



**Advanced Energy® AE 500 Inverter  
Installation and Operation  
User Manual**

March 2012 570-1001791-05A







A POWERFUL ADVANTAGE™

# Advanced Energy® AE 500 Inverter Installation and Operation User Manual

March 2012 570-1001791-05A

## COPYRIGHT

This manual and the information contained herein are the proprietary property of Advanced Energy Industries, Inc.

No part of this manual may be reproduced or copied without the express written permission of Advanced Energy Industries, Inc. Any unauthorized use of this manual or its contents is strictly prohibited. Copyright © 2012 Advanced Energy Industries, Inc. All Rights Reserved.

## DISCLAIMER AND LIMITATION OF LIABILITY

The information contained in this manual is subject to change by Advanced Energy Industries, Inc. without prior notice. Advanced Energy Industries, Inc. makes no warranty of any kind whatsoever, either expressed or implied, with respect to the information contained herein. Advanced Energy Industries, Inc. shall not be liable in damages, of whatever kind, as a result of the reliance on or use of the information contained herein.

## PRODUCT USAGE STATEMENT



### **WARNING :**

Read this entire manual and all other publications pertaining to the work to be performed before you install, operate, or maintain this equipment. Practice all plant and product safety instructions and precautions. Failure to follow instructions can cause personal injury and/or property damage. If the equipment is used in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired. All personnel who work with or who are exposed to this equipment must take precautions to protect themselves against serious or possibly fatal bodily injury.

Advanced Energy Industries, Inc., (AE) provides information on its products and associated hazards, but it assumes no responsibility for the after-sale operation of the equipment or the safety practices of the owner or user. **NEVER DEFEAT INTERLOCKS OR GROUNDS.**

Any use of the AE 500 unit that is not expressly authorized in this user manual or associated documentation, including, without limitation, the use of the AE 500 unit with incompatible photovoltaic panel technology, is expressly prohibited by AE, and AE disclaims any responsibility or liability for such prohibited use. The AE 500 unit should only be handled, installed, operated, and maintained by trained personnel.

**AVERTISSEMENT :**

Lire ce manuel au complet ainsi que toutes les autres publications portant sur le travail à effectuer avant d'installer, d'utiliser ou d'entretenir cet équipement. Pratiquer toutes les instructions et précautions de sécurité pour l'usine et les produits. Tout manquement aux instructions suivantes peut provoquer des blessures corporelles et/ou des dommages matériels. Si l'équipement est utilisé de manière non spécifiée par le fabricant, la protection fournie par l'équipement peut être compromise. Tous les membres du personnel travaillant sur cet équipement ou qui y sont exposés doivent observer les précautions pour se protéger contre des blessures graves, voire mortelles.

Advanced Energy Industries, Inc. (AE) fournit des renseignements sur ses produits et les dangers qui y sont liés, mais ne peut être tenue responsable du fonctionnement après-vente de l'équipement ou des pratiques de sécurité du propriétaire ou de l'utilisateur. **NE JAMAIS DÉJOUER LES DISPOSITIFS DE PROTECTION À VERROUILLAGE OU LES MISES À LA TERRE.**

Toute utilisation de cette unité AE 500 qui n'est pas expressément autorisée dans ce guide de l'utilisateur ou dans la documentation connexe, y compris, sans s'y limiter, l'utilisation de l'unité AE 500 avec des technologies de panneaux photovoltaïques incompatibles, est expressément interdite par AE, et AE décline toute responsabilité découlant d'un tel usage interdit. L'unité AE 500 doit seulement être manipulée, installée, utilisée et entretenue par un personnel formé.

## TRADEMARKS



is a registered trademark of Advanced Energy Industries, Inc.

PVPowered™ is a trademark of Advanced Energy Industries, Inc.

Power Factor Pro™ is a trademark of Advanced Energy Industries, Inc.

Advanced Power Controls™ is a trademark of Advanced Energy Industries, Inc.

Modbus® is a registered trademark of Gould, Inc.

Windows® is a registered trademark of the Microsoft Corporation.

## CUSTOMER FEEDBACK

Advanced Energy's technical writing staff has carefully developed this manual using research-based document design principles. However, improvement is ongoing, and the writing staff welcomes and appreciates customer feedback. Please send any comments on the content, organization, or format of this user manual to:

- [tech.writing@aei.com](mailto:tech.writing@aei.com)

To order a manual, please contact AE Solar Energy Technical Support:

- [invertersupport@aei.com](mailto:invertersupport@aei.com)

# Table of Contents

## Chapter 1. Safety and Product Compliance Guidelines

Important Safety Instructions .....	1-1
Save These Instructions .....	1-1
Danger, Warning, and Caution Boxes in the Manual .....	1-1
Safety Guidelines .....	1-2
Rules for Safe Installation and Operation .....	1-2
Personal Safety .....	1-3
Medical and First Aid Treatment .....	1-3
Safety Equipment Requirements .....	1-3
Interpreting Product Labels .....	1-3
Product Compliance .....	1-4
Safety and EMC Directives and Standards .....	1-5
Safety Directives and Standards .....	1-5
Electrical Safety .....	1-5
Disconnect Switch .....	1-5
Wiring Requirements .....	1-6
Wiring Information .....	1-6
Fire Prevention .....	1-8
Lockout and Tagout Requirements .....	1-8
Acronyms and Frequently Used Terms .....	1-9

## Chapter 2. Product Overview

General Description .....	2-1
Advanced Energy Inverter Models .....	2-1
Design Features .....	2-1
Product Features .....	2-2
Major Components and Functional Parts .....	2-3
Power Module Assembly .....	2-4
Control Electronics .....	2-4
Data Monitoring Card Cage .....	2-5
Communications Interface PCB .....	2-6
Operator Interface Controls .....	2-6
Active Cooling System .....	2-7
DC Combiner Sub Panel .....	2-7
DC Sub Panel .....	2-7
AC Sub Panel .....	2-8
Housekeeping Transformer .....	2-9
Magnetics Compartment .....	2-9

## Chapter 3. Planning

---

General Requirements for Planning and Installation .....	3-1
Handling the Inverter .....	3-1
Handling Options .....	3-2
Storage .....	3-2
Location and Clearances .....	3-2
Location .....	3-2
Noise .....	3-2
Recommended Clearances .....	3-2
Conduit and Conductors .....	3-3
Environmental Requirements .....	3-4
Grounding and Neutral Requirements .....	3-4
PV Array Frame Grounding .....	3-4
System Neutral .....	3-5
Utility Grid Interconnection .....	3-6
Utility Connection Requirements .....	3-6
Contacting Your Local Utility .....	3-6
Voltage Output .....	3-6
Inverter Monitoring .....	3-6
Calculating DC Input Voltage .....	3-7
DC Combiner Sub Panel Options .....	3-7
Breaker Protection for DC Input .....	3-8

## Chapter 4. Installing

Handling and Unpacking .....	4-1
Packaging Contents .....	4-1
Handling and Unpacking the Inverter .....	4-1
Installing the Air Intake Hoods .....	4-2
Pre-Installation Inspection .....	4-5
Pre-Installation Inspection Tools .....	4-5
Step 1: External Inspection .....	4-6
Step 2: Inspection of Rear Magnetics .....	4-6
Step 3: AC and DC Sub Panel Compartments .....	4-7
Step 4: Power Module Compartment .....	4-8
Step 5: Upper Active Cooling Compartment .....	4-9
Lifting and Mounting the Inverter .....	4-10
Conduit Entry Points .....	4-12
Using Gland Plates for Cable Conduit Entry and Exit .....	4-12
Electrical Connections .....	4-15
AC Wiring .....	4-16
Connecting to the Electrical Grid .....	4-18
DC Wiring .....	4-21
Connecting to the PV Arrays .....	4-22
Using the Integrated Remote Disable Input .....	4-25
Making the Remote Disable Connection .....	4-26
24 V Power Supply .....	4-28
Wiring the 24 V Power Supply .....	4-29

## Chapter 5. Operation

System Startup Procedure .....	5-1
Inverter Operating States .....	5-2
Display Screens and Operation .....	5-4
To Operate the Display .....	5-6
Ground Fault Interrupt Device .....	5-6
To Respond to a Ground Fault .....	5-7
To Shutdown the Inverter .....	5-8
De-energize/Isolation Procedures .....	5-9
Inverter Enable/Disable Controls .....	5-10

## Chapter 6. Data Monitoring and Controls

Networking and Performance Monitoring .....	6-1
Ethernet Network Connection .....	6-1
Connecting the Ethernet Cable .....	6-2
To Establish an Internet Connection with the Inverter .....	6-3
To Verify Data Monitoring Connectivity .....	6-4
Modbus Overview .....	6-4
Modbus Communication Protocol .....	6-4
Networking Using the Modbus Option .....	6-4
Modbus TCP Installation .....	6-5
Modbus TCP Network Configuration .....	6-6
Networking Using the Modbus RS-485 Option .....	6-6
Network Layout .....	6-7
Installing the Modbus RS-485 Cable .....	6-8
Setting the DIP Switches .....	6-9
To Terminate the Inverter Network .....	6-10
To Set the Center Inverters for the Network .....	6-11
To Set Network Biasing .....	6-11
To Terminate the Network and Enable Biasing .....	6-11
Setting the Modbus Address .....	6-11
Modbus Commands .....	6-16
Modbus Command Format .....	6-16
Return Slave ID .....	6-18
Modbus Data Types .....	6-19
Modbus Register Mapping .....	6-19
Modbus Fixed Information Registers .....	6-19
Modbus Data Registers .....	6-22
Modbus Status and Fault Code Registers .....	6-23
Modbus Command Registers .....	6-26

## Chapter 7. Maintenance

---

Visual Inspection .....	7-2
Maintenance Schedule .....	7-2
Replacement Parts .....	7-3
Checking and Replacing the Air Filters .....	7-4
Maintaining the Air Filters .....	7-4
Maintaining the Card Cage Air Filter .....	7-6
Replacing the Battery on the Communications PCB .....	7-6

## Chapter 8. Troubleshooting and Solar Energy Technical Support

Troubleshooting LAN Connectivity .....	8-1
To Test the LAN Cable .....	8-2
Troubleshooting Warnings and Faults .....	8-2
Troubleshooting Warnings .....	8-3
System Warnings .....	8-3
Troubleshooting Inverter Faults .....	8-4
AC Under Voltage Fault .....	8-5
Ground Faults .....	8-5
To Resolve a Ground Fault .....	8-6
Inverter Fault Codes .....	8-8
PCB Status LEDs .....	8-13
Controller PCB Status LEDs .....	8-13
Communication PCB Status LEDs .....	8-14
AE Solar Energy Technical Support .....	8-18

## Appendix A. Specifications

Physical Specifications .....	A-1
Electrical Specifications .....	A-1
Efficiency Specifications .....	A-4
Efficiency Curves for the PVP500kW (480 VAC) Model .....	A-4
Cooling Specifications .....	A-4
Environmental Specifications .....	A-5

## Appendix B. System and Mechanical Diagrams

System Diagram .....	B-1
Mechanical Diagrams .....	B-2

# List of Tables

Table 1-1. Branch breaker size recommendations .....	1-6
Table 1-2. Acronyms and frequently used terms .....	1-9
Table 3-1. Inverter clearances .....	3-2
Table 3-2. Cooling and heat rejection rate requirements .....	3-4
Table 4-1. Subcombiner wire sizing and torque values .....	4-16
Table 4-2. Branch breaker size recommendations .....	4-17
Table 4-3. Operational voltage ranges per electrical panel .....	4-18
Table 5-1. Inverter enable/disable .....	5-10
Table 6-1. Maximum network length per Modbus bit rate .....	6-10
Table 6-2. Inverter address table .....	6-13
Table 6-3. Modbus commands .....	6-16
Table 6-4. Format for Read Holding Register command .....	6-16
Table 6-5. Response format for Read Holding Register command .....	6-17
Table 6-6. Format for Write Single Register command .....	6-17
Table 6-7. Response format for Write Single Register command .....	6-17
Table 6-8. Format for Return Slave ID .....	6-18
Table 6-9. Format for Return Slave ID command .....	6-18
Table 6-10. Data types .....	6-19
Table 6-11. Modbus fixed information registers .....	6-20
Table 6-12. Inverter model number .....	6-21
Table 6-13. Bit mapping for inverter configuration register .....	6-21
Table 6-14. Modbus data registers .....	6-22
Table 6-15. Modbus status and fault code registers .....	6-23
Table 6-16. Modbus inverter operating status register values .....	6-24
Table 6-17. PVM status register status code values .....	6-25
Table 6-18. Modbus command registers .....	6-26
Table 7-1. Maintenance checklist .....	7-3
Table 7-2. Inverter replacement parts .....	7-4
Table 8-1. Inverter system warnings .....	8-4
Table 8-2. Fault categories .....	8-8
Table 8-3. Drive (DRV) faults .....	8-9
Table 8-4. Voltage (VLT) faults .....	8-10
Table 8-5. Grid (GRD) faults .....	8-11
Table 8-6. Temperature (TMP) faults .....	8-12
Table 8-7. System (SYS) faults .....	8-12
Table 8-8. Controller PCB LEDs .....	8-13
Table 8-9. Link LED .....	8-15
Table 8-10. Activity LED .....	8-15
Table 8-11. Status LED .....	8-16
Table 8-12. Modbus LED .....	8-17
Table 8-13. AE Solar Energy Technical Support 24 X 7 contact information .....	8-18
Table A-1. Physical specifications .....	A-1
Table A-2. Electrical specifications .....	A-2
Table A-3. Utility interconnect voltage and frequency trip limits and times .....	A-3
Table A-4. Efficiency specifications for the PVP500kW (480 VAC) model .....	A-4

Table A-5. Cooling specifications .....	A-4
Table A-6. Environmental specifications .....	A-5

# List of Figures

Figure 2-1. Components of the AE 500 inverter .....	2-3
Figure 2-2. Power module assembly .....	2-4
Figure 2-3. Control electronics compartment .....	2-5
Figure 2-4. Data monitoring card cage assembly .....	2-6
Figure 2-5. DC combiner sub panel .....	2-7
Figure 2-6. DC sub panel .....	2-8
Figure 2-7. AC sub panel .....	2-8
Figure 3-1. Inverter clearances .....	3-3
Figure 3-2. DC subcombiner options .....	3-8
Figure 4-1. Stacked air intake hoods .....	4-3
Figure 4-2. Placing the air intake hood on the inverter .....	4-4
Figure 4-3. Hinge on the air intake hood - locked and open positions .....	4-4
Figure 4-4. Attaching the hood's gas springs to the inverter .....	4-5
Figure 4-5. Inductor and transformer connections .....	4-6
Figure 4-6. Bus bar connection inspection .....	4-7
Figure 4-7. Pull test of cable screw terminal connection .....	4-8
Figure 4-8. Screen inspection .....	4-8
Figure 4-9. Check the bus bar connections .....	4-9
Figure 4-10. Fan inspection .....	4-9
Figure 4-11. Air filter check .....	4-10
Figure 4-12. DC bottom entry gland plates .....	4-13
Figure 4-13. DC side entry gland plates .....	4-14
Figure 4-14. Installation of conduit hub .....	4-14
Figure 4-15. AC connections .....	4-20
Figure 4-16. Bus bar connections .....	4-20
Figure 4-17. DC connections .....	4-22
Figure 4-18. DC subcombiner configurations .....	4-23
Figure 4-19. DC dead front .....	4-24
Figure 4-20. DC inverter connections .....	4-25
Figure 4-21. Remote disable wiring diagram .....	4-27
Figure 4-22. Remote disable terminal block .....	4-28
Figure 4-23. 24 V power supply terminal location .....	4-29
Figure 4-24. 24 V wiring example .....	4-30
Figure 5-1. Inverter with AC disconnect power ON .....	5-2
Figure 5-2. Inverter state diagram .....	5-3
Figure 5-3. Initialize state screen .....	5-5
Figure 5-4. Energy tracking state screens .....	5-5
Figure 5-5. Fault state screens .....	5-5
Figure 5-6. Warning state screen .....	5-6
Figure 5-7. Disabled state screen .....	5-6
Figure 5-8. Inverter display and switch .....	5-6
Figure 5-9. Ground fault error message .....	5-7
Figure 5-10. AC disconnect power OFF .....	5-8
Figure 6-1. T-568B compliant Ethernet cable .....	6-2
Figure 6-2. Communication interface PCB Ethernet port location .....	6-3

---

Figure 6-3. Communication interface PCB in the data monitoring section .....	6-6
Figure 6-4. Daisy chain layout for RS-485 network: option A .....	6-7
Figure 6-5. Daisy chain layout for RS-485 network: option B .....	6-7
Figure 6-6. Daisy chain layout for RS-485 network: option C .....	6-7
Figure 6-7. Communications interface PCB with Modbus slave port location .....	6-9
Figure 6-8. Termination switches on the user interface PCB .....	6-10
Figure 6-9. Setting the Modbus address .....	6-12
Figure 6-10. Example: Unit address switch set to address 25 .....	6-13
Figure 7-1. Air intake hoods .....	7-5
Figure 7-2. Air intake hood in raised position .....	7-5
Figure 7-3. Card cage air filter .....	7-6
Figure 8-1. Warning screen .....	8-3
Figure 8-2. Screen sequence when an inverter faults .....	8-5
Figure 8-3. Communication PCB with status LEDs .....	8-14
Figure 8-4. Communication interface PCB with LEDs .....	8-15
Figure A-1. Efficiency curves for the PVP500kW (480 VAC) model .....	A-4
Figure B-1. AE 500 system diagram .....	B-1
Figure B-2. AE 500 mechanical diagram: View 1 .....	B-2
Figure B-3. AE 500 mechanical diagram: View 2 .....	B-3
Figure B-4. AE 500 mechanical diagram: View 3 .....	B-4

# Safety and Product Compliance Guidelines

## IMPORTANT SAFETY INSTRUCTIONS

To ensure safe installation and operation of the Advanced Energy AE 500 unit, read and understand this manual before attempting to install and operate this inverter. At a minimum, read and follow the safety guidelines, instructions, and practices.

## SAVE THESE INSTRUCTIONS

This manual contains important instructions for the AE 500 unit that shall be followed during installation and maintenance of the unit.

## DANGER, WARNING, AND CAUTION BOXES IN THE MANUAL



This symbol represents important notes concerning potential harm to people, this unit, or associated equipment. Advanced Energy includes this symbol in Danger, Warning, and Caution boxes to identify specific levels of hazard seriousness.



### DANGER:

DANGER indicates an imminently hazardous situation that, if not avoided, will result in death or serious injury. DANGER is limited to the most extreme situations.



### DANGER:

DANGER indique une situation dangereuse imminente qui, si elle n'est pas évitée, pourrait provoquer la mort ou des blessures graves. DANGER est réservé aux situations les plus extrêmes.



**WARNING:**

WARNING indicates a potentially hazardous situation that, if not avoided, could result in death or serious injury, and/or property damage.



**AVERTISSEMENT:**

AVERTISSEMENT indique une situation potentiellement dangereuse qui, si elle n'est pas évitée, pourrait provoquer la mort ou des blessures graves et/ou des dommages matériels.



**CAUTION:**

CAUTION indicates a potentially hazardous situation that, if not avoided, could result in minor or moderate injury, and/or property damage. CAUTION is also used for property-damage-only accidents.



**ATTENTION:**

ATTENTION indique une situation potentiellement dangereuse qui, si elle n'est pas évitée, pourrait provoquer des blessures mineures ou modérées et/ou des dommages matériels. ATTENTION est également utilisé pour des accidents causant uniquement des dommages matériels.

## SAFETY GUIDELINES

Review the following information before attempting to install and operate the product.

### Rules for Safe Installation and Operation

Please note the following rules:

- Do not attempt to install or operate this equipment without proper training.
- Ensure that this unit is properly grounded.
- Ensure that all cables are properly connected.
- Verify that input line voltage and current capacity are within specifications before turning on the power supplies.
- Use proper electrostatic discharge (ESD) precautions.
- Always be careful around this equipment.

## PERSONAL SAFETY

Ensure any personnel entering a safety zone within a four foot area around any operating inverter wear appropriate Personal Protective Equipment (PPE) as mandated by national, state, and local authorities.

### Medical and First Aid Treatment

Personnel working in and around operating power generation equipment should be trained in Arc Flash Hazard, Fire Extinguisher selection and use, First Aid, Cardio Pulmonary Resuscitation (CPR), and Automated External Defibrillator (AED) use (if available).

### Safety Equipment Requirements

Authorized service personnel performing operations on this unit should have the following minimum safety equipment available:

- Consult NFPA 70E, or applicable local standards, for PPE requirements on switch gear operating at less than 600 V
- Electrical hazard footwear (ANSI Z41/Z85 rated)
- Lock Out Tag Out (LOTO) Kit
- Appropriate meter to verify the circuits are safely de-energized (1000 VAC and DC rated, minimum)
- Any other equipment as applicable to your operation as required by national, state, and local regulations

## INTERPRETING PRODUCT LABELS

The following labels may appear on your unit:



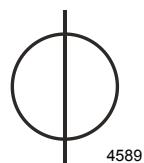
Earth ground



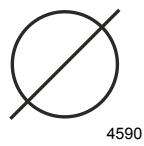
Chassis ground



On or off



Phase



Electrical fuse



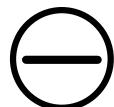
Alternating current



Direct current



Positive ground



Negative ground

## PRODUCT COMPLIANCE

The following sections include information about unit compliance and certification, including the conditions of use required to be in compliance with the standards and directives.

## Safety and EMC Directives and Standards

Certain options of this unit have been tested for and comply with the following electromagnetic compatibility (EMC) and safety directives and standards and industry guidelines.

### **Important**

This equipment must be installed and used in accordance with the Conditions of Use described in this manual. If this equipment is expanded, modified, or installed into a larger system, the user is responsible to guarantee the compliance of the overall system. If this equipment is used with external components, the user must ensure that the Safety and EMC requirements are not violated.

## SAFETY DIRECTIVES AND STANDARDS

- **UL1741**

Inverters, Converters, Controllers and Interconnection System Equipment for Use With Distributed Energy Resources (2010)

- **IEEE 1547**

Standard for Interconnecting Distributed Resource with Electric Power Systems

- **IEEE 1547.1**

Standard for Conformance Tests Procedures for Equipment Interconnecting Distributed Resources with Electric Power Systems

- **FCC Part 15 Class A** conducted emissions

- **CSA C22.2 No. 107.1-01**

General use power supplies—industrial products

- **National Electrical Code**

Can be installed in compliance with National Electrical Code 2008 and 2011 Editions Article 690 Solar Photovoltaic Systems

## Electrical Safety

### DISCONNECT SWITCH

The inverter is equipped with an AC disconnect (power OFF) to stop power conversion within the inverter. Before accessing the interior of the cabinet, this disconnect must be in the OFF position. Since this disconnect only stops power conversion within the inverter, both the external (or optional inverter integrated) DC (photovoltaic array) and AC (utility grid) circuits must be isolated in order to fully ensure the inverter is de-energized. Wait five minutes for the inverter to de-energize before working on the inverter.

## AC/DC DISCONNECT DEVICE AND OTHER REQUIREMENTS

If the optional inverter integrated AC disconnect and inverter integrated DC subcombiner breakers were not selected, then isolated disconnect devices must be provided for both the PV array DC connection and for the AC utility grid connection when installing an AE inverter.

## AC DISCONNECT DEVICE, OVERCURRENT PROTECTION, AND TRANSFORMER REQUIREMENTS

If the optional inverter integrated AC disconnect was not selected, then you must install an AC disconnect and overcurrent protection device at the AE inverter that complies with National Electric Code ANSI/NFPA 70 and local building code requirements, whichever is more restrictive. The AC disconnect must be rated for 480 VAC at the maximum overcurrent protection setting, typically  $1.25 * I_{AC}$  maximum. You must connect the inverter to a three-phase 480 VAC grounded wye feeder or an 800 A service. Refer to the table below.

## DC DISCONNECT DEVICE AND FUSE REQUIREMENTS

If the optional DC subcombiner circuit breakers were not selected, then you must provide a DC disconnect and fusing for each section (or sub-array) of the PV array. The disconnect must be rated for the voltage and the current rating of the photovoltaic array connected to the inverter. The DC disconnect installation must comply with your national and local electrical code.

## Wiring Requirements

You must meet the following requirements when wiring the AE 500 inverter:

*Table 1-1. Branch breaker size recommendations*

Model	208 VAC	480 VAC	600 VAC
AE 500	N/A	800 A	N/A

## WIRING INFORMATION



### Important

You must use National Electrical Code (ANSI/NFPA 70) wiring methods.



### DANGER:

Do not connect the PV negative or positive conductors to the ground bus bars provided. The PV array is grounded through the integral GFDI. Connecting the PV array positive or negative conductors to ground at any other point in the system would defeat the ground fault protection circuit.

**DANGER:**

Ne pas brancher les conducteurs négatifs ou positifs du PV aux barres omnibus mises à la terre fournies. Le panneau photovoltaïque est mis à la terre au moyen du GFDI. La connexion des conducteurs positifs ou négatifs du panneau photovoltaïque à la terre à tout autre point du système pourrait déjouer le circuit de protection contre les défauts de terre.

- All wiring methods and materials shall be in accordance with the National Electrical Code ANSI/NFPA 70 as well as all state and local code requirements.
- When sizing conductors and conduits for connection to the AE 500 inverter, both shall be in accordance with the National Electrical Code ANSI/NFPA 70, as well as state and local code requirements.
- The AC power conductor bus bar connections in the inverter should be tightened to the torque value specified in the installation instructions. Each conductor should be connected separately to the bus bar.
- The DC power conductor bus bar connections in the inverter should be tightened to the torque value specified in the installation instructions. Each conductor should be connected separately to the bus bar.
- AC overcurrent protection for the utility interconnect (grid-tie) must be provided by the installers as part of the inverter installation.
- Installations in Canada should be in accordance with the Canadian Electrical Code (CEC) or applicable local standards.
- Use only conductors with an insulation rating of 90°C minimum insulation rating.
- This equipment is intended to be installed as part of a permanently grounded electrical system per the NEC or local standards.

The inverter is electrically connected to the DC photovoltaic array in the DC combiner sub panel which includes a positive, negative, and grounded bus bar. The PV array is grounded internally by means of the GFDI.

The inverter can be ordered with an optional subcombiner with DC circuit breakers. The subcombiners have individual input terminals for each circuit breaker. These terminals require the use of a torque wrench to properly install the interface cables. Use proper torque values of DC subcombiner box wire mounting hardware.

The inverter is factory configured for the appropriate three-phase output:

- AE 500 is 480 VAC

The inverter is electrically connected to the utility grid at the AC landing within the AC section on the front right side of the inverter. These terminals require the use of a UL-approved connector certified for use with the selected interface cables:

- Crimp-on type ring terminal
- Compression type lug

Ensure phase cables run together through conduit and gland plates, which allows any inductive currents produced to be cancelled out. Use proper torque values for terminal lug mounting hardware.

A copper clad earth grounding electrode must be installed within three feet (one meter) of the unit. The AC ground busbar located in the AC section, lower front compartment, must be used as the single point connection to the earth grounding electrode for the inverter system. For the convenience of installers, a DC ground bus bar is provided. The DC and AC ground bus bars are solidly bonded together inside the cabinet. If present, a DC Grounding Electrode Conductor (GEC) may be bonded to the DC ground bar. Where permitted by NEC, a single conductor that meets all the requirements of both DC GEC and AC equipment ground may be bonded to the AC ground bar.

AC overcurrent protection for the utility interconnect (grid-tied) must be provided by installers as part of the installation.

## Fire Prevention

Care must be exercised when installing DC and AC connections within the inverter. Follow all instructions in this manual to ensure proper and safe operation of this unit.



### DANGER:

Risk of electrical shock. In the event of a fire, disconnect power to the inverter and do not attempt to use a water based fire extinguisher. Utilize only a Class C extinguisher rated for electrical fire.



### DANGER:

Risque d'électrocution. Dans l'éventualité d'un incendie, débranchez l'onduleur du secteur et n'utilisez pas d'extincteur à base aqueuse. Utilisez uniquement les extincteurs de classe C conçus pour combattre les feux électriques.

## LOCKOUT AND TAGOUT REQUIREMENTS

To prepare the AE 500 unit for maintenance or troubleshooting, you must de-energize and isolate the AC and the DC interface energy sources before working on the unit.

# ACRONYMS AND FREQUENTLY USED TERMS

*Table 1-2. Acronyms and frequently used terms*

Term	Description
Action delay	A predefined delay before a set point change.
A/D	Analog to digital conversion
ANSI	American National Standards Institute
BEMS	Building energy management system
CFM	Cubic feet per minute
Curtailment	A reduction of the power output level for scheduled capacity or energy delivery. Allows limiting of system output power. Also known as power throttling.
DHCP	Dynamic host configuration protocol
DNS	Domain name service
DSP	Digital signal processor
DVI	Digital video interface
EMI	Electromagnetic interference
ESD	Electro static discharge
GEC	Grounding electrode conductor
GFDI	Ground fault detector interruptor
IEEE	Institute of Electrical and Electronics Engineers
IGBT	Insulated gate bipolar transistor
Inverter	Also called the switching section or engine, this is the part of the unit that inverts DC current to AC current.
IP	Internet protocol
Lagging	Current follows, or lags, voltage in an inductor. A source producing power with a lagging power factor reduces the utility grid voltage.
Leading	Current leads the voltage in a capacitor. A source producing power with a leading power factor increases the grid voltage.
LOTO	Lockout Tagout
MCM	1000 circular mils utilized in wire sizing
MPPT	Maximum power point tracking
NEC	National Electric Code
NFPA	National Fire Protection Association

**Table 1-2. Acronyms and frequently used terms (Continued)**

Term	Description
NTP	Network time protocol
OEM mode	Original equipment manufacturer mode
PCB	Printed circuit board
PF	Power factor
PLL	Phase lock loop
PPE	Personal protective equipment
PV	Photovoltaic
PVM	PV monitoring
PVM Sync	Software application used to query inverters.
PWM	Pulse width modulation
Ramp rate	Changes in the inverter's power output at a controlled rate either to increase or decrease power delivery.
Randomize	Allows a random delay before a set point change. The delay will change every set point change.
Remote enable/disable	The inverter system can be remotely turned on or off. The inverter restarts after a five minute countdown.
RMS	Root mean squared
SCADA	Supervisory control and data acquisition. A computer system that monitors and controls infrastructure or facility-based processes.
Set point	Inverter is operating and delivering power at defined parameters.
SPF	Scheduled power factor
SVAr	Static volts-amps reactive
UL	Underwriter's Laboratory
UTC	Universal time coordinate. Also known as Greenwich mean time.
VAC	Voltage alternating current
VAr	Volts-amps reactive
VDC	Voltage direct current
VFD	Vacuum fluorescent display
Voc	Voltage open circuit

# Product Overview

## GENERAL DESCRIPTION

The Advanced Energy inverter is designed to act exclusively as a grid-tied inverter for photovoltaic (PV) systems. The inverter converts direct current (DC) electricity generated by the photovoltaic arrays into usable alternating current (AC) electricity. This means the inverter must be tied to the utility grid and a photovoltaic system in order to operate properly. Because the inverter is tied to a local utility source, if local electrical load exceeds the power generated by the solar array, the grid automatically supplies the additional electricity needed. Likewise, if the inverter produces more power than is needed, it feeds the excess power back into the electrical grid.

## Advanced Energy Inverter Models

This manual provides the information necessary to successfully install and operate the applicable Advanced Energy inverter.

Within the AE product line some inverter models can be factory configured with different three-phase outputs. See the specifications for more information.

For specific product characteristics, refer to the specifications in Appendix A.

## DESIGN FEATURES

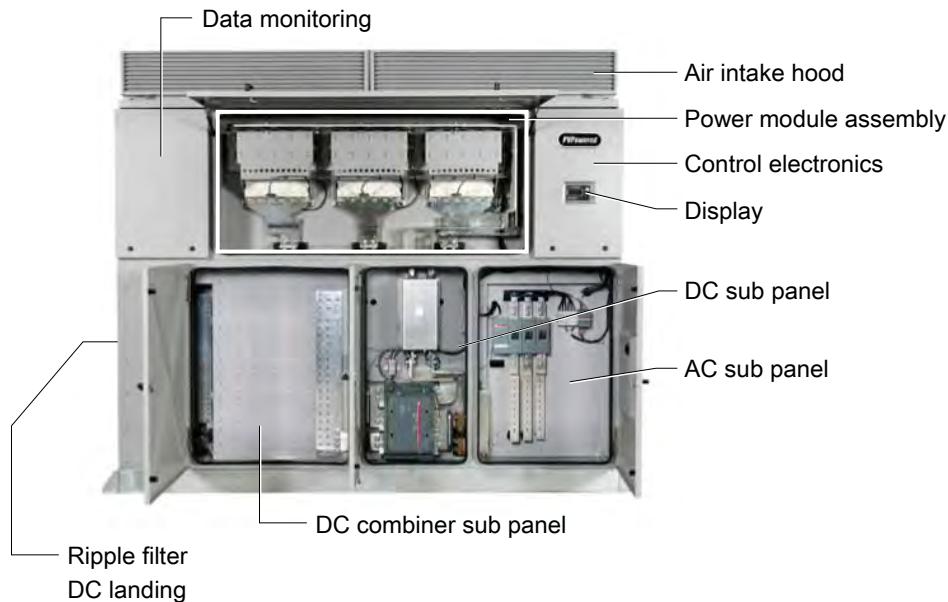
- Easy installation: The AE inverter is built for easy installation. To minimize installation efforts, this inverter features an integrated isolation transformer and optional integrated AC disconnect in a compact single cabinet. The inverter can be ordered with a range of DC subcombiner designs for maximum adaptability for the desired system operating scheme.
- Simple, innovative design: The AE inverter is a fully integrated solution with standard integrated data monitoring available and an optional premium data monitoring solution. This modular design enables rapid field service and upgrades. The inverter can quickly and easily be installed in any location, indoors or out.
- Adaptability: The PV Powered inverter has a standard DC Maximum Power Point Tracking (MPPT) range from 310 V to 595 V. The maximum input voltage is 600 VDC.
- Versatility: The AE inverter is designed for flexibility and can be used for a range of commercial applications, accommodating most PV system configurations.

## PRODUCT FEATURES

The design of the AE 500 inverter includes the following standard features.

- Equipped with redundant cooling system with variable speed fans and fault detection. The built-in backup capabilities enables the inverter to deliver full power at the maximum rated temperature even if one of the fans should fail. Fan status is reported as a warning shown on the display and through remote monitoring.
- Includes anti-islanding protection and monitoring functions to prevent the inverter from feeding power to the utility grid in the event of a utility outage.
- Utilize EMI input and output filtration to prevent electromagnetic interference.
- Field-selectable voltage and frequency trip points constantly track the AC current within the unit, limiting the inverter current output.
- Remote monitoring system using a standard Ethernet data reporting and communications interface PCB. With a high speed connection, this interface can provide PV system performance data in the following methods:
  - Subscribe to the standard monitoring service on the secure AE website. This recommended method allows the user to track the PV system and inverter information online. The basic monitoring service is available to all registered users.
  - Provide data to incentive-based performance monitoring and reporting programs for third parties.
- Inverter control through Modbus/TCP or Modbus/RTU for standard and optional features:
  - Power curtailment
  - Power factor control
  - Monitoring
  - Remote disable
- Inverter remote disable for remote control by opening an external switch or set of contacts.

## MAJOR COMPONENTS AND FUNCTIONAL PARTS



**Figure 2-1.** Components of the AE 500 inverter

The modular design of the inverter makes them easy to access and service. As shown in the preceding illustration the inverter is composed of two main sections:

- The upper compartments contains the power module assembly for the power conversion electronics including:
  - Power module assembly
  - Control printed circuit boards (PCB)
  - Power distribution PCB
  - Power supply
  - Active cooling system
  - Dedicated data monitoring in the left compartment
- The lower and magnetics compartments house the following:
  - DC combiner sub panel contains the optional DC breaker subcombiner, optional subcombiner monitoring, and the positive, negative, and ground bars
  - DC sub panel with the DC line filter, DC surge protection, and DC contactor
  - AC sub panel with AC output filtering, surge protection, optional AC disconnect, and AC connection points
  - Magnetics compartment contains the isolation transformer and inductors

## Power Module Assembly

The inverter uses insulated gate bipolar transistors (IGBTs) for converting DC power into three-phase AC power. The inverter is protected by over-current, over-voltage, and over-temperature detection controls. If a protection system is activated, the power module will cease power conversion and send an interrupt signal to the digital signal processor (DSP).



Power module assembly

*Figure 2-2. Power module assembly*

## Control Electronics

The control electronics PCB is located in the upper right compartment. This PCB includes the control electronics card cage and the ground fault detector interrupter (GFDI) circuit. The purpose of the GFDI is to detect a ground fault (unintended current flow from the solar panels to earth ground) and in the event of a ground fault, stop AC power production.

The control electronics card cage houses the following PCBs:

- Power distribution PCB: Distributes the required logic level voltages for use throughout the inverter.
- Controller PCB: Contains a powerful DSP that controls sine wave generation, logic functions, and protection activities. All analog and digital inputs and outputs are routed to the control PCB and fed to the DSP.
- Inverter interface PCB: Provides a central location for a range of input, output, and control circuits.

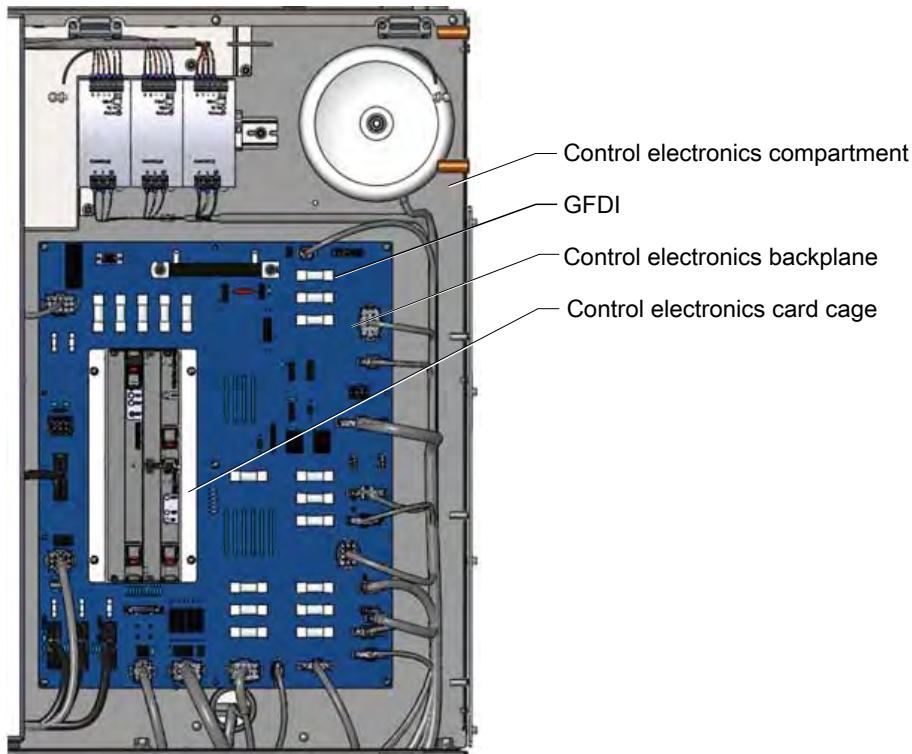


Figure 2-3. Control electronics compartment



**WARNING:**

Risk of electrical shock. The GFDI functions using a fuse to connect or bond the solar array negative (or the solar array positive, if using a positively grounded panel array) to earth ground.



**AVERTISSEMENT:**

Risque d'électrocution. Les fonctions GFDI utilisent un fusible pour connecter ou lier le négatif du panneau solaire (ou le positif du panneau solaire, si l'on utilise un panneau mis à la masse du positif) à la prise de terre.

If the ground fault current exceeds 5 A between the grounded array terminal and the earth ground, the GFDI fuse will open and disconnect the solar panels from their ground reference, interrupting the ground fault. In this situation, the inverter will cease operation, display a fault message, and the LED on the inverter interface PCB will illuminate red. If a GFDI current of 3 A to 5 A exists, the inverter will indicate a ground fault warning.

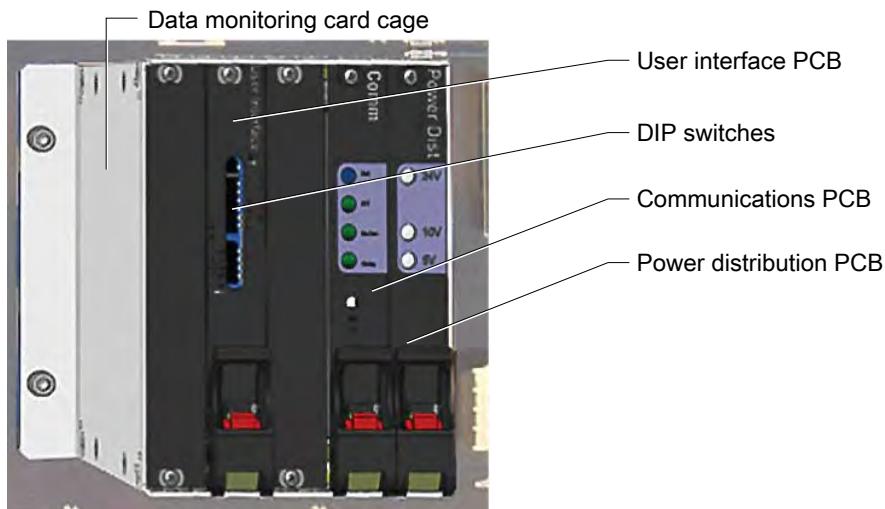
## Data Monitoring Card Cage

The data monitoring compartment in the upper left section of the inverter houses the data monitoring and the communications interface PCBs along with the optional AE premium data monitoring gateway.

The data monitoring card cage houses the following:

- Communications PCB: Provides serial, internet, and Modbus communications.
- Power distribution PCB: Distributes the required logic level voltages for use throughout the inverter.
- User interface PCB: Provides accessible DIP switches for Modbus addressing and termination.

The data monitoring card cage assembly in the following figure is designed to enable fast and easy service and also acts as an EMI shield to ensure signal integrity on the PCBs.



*Figure 2-4. Data monitoring card cage assembly*

## COMMUNICATIONS INTERFACE PCB

The communications interface PCB is the backplane for the data monitoring card cage assembly. This PCB contains the following:

- RJ45 Ethernet port that is used to connect the inverter to the internet
- Modbus/RTU connection
- Serial port is available for AE Solar Energy Technical Support use only
- Remote disable and inverter status connections
- 24 V auxiliary power supply connector

## Operator Interface Controls

The vacuum fluorescent display (VFD) located on the front upper right of the inverter cabinet includes both a digital display screen and two buttons. The display screen shows the inverter's state, scrolling continuously through the screens. The **Scroll/Pause** button controls the display screen and the **ON/OFF** switch enables or disables the inverter.

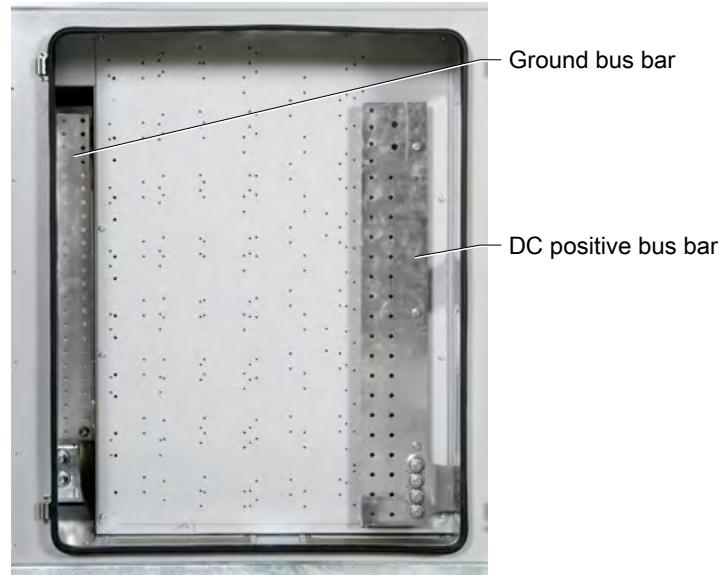
## Active Cooling System

The inverters come with fans which activate as needed to keep the internal components within preset temperature limits. These fans are located on each side of the inverter.

## DC Combiner Sub Panel

The DC combiner sub panel compartment is where the inverter connections to the PV source circuits are completed, including the positive, negative, and ground bus bars.

Optional DC circuit breaker subcombiner and subcombiner monitoring are also located in the DC combiner sub panel if selected.

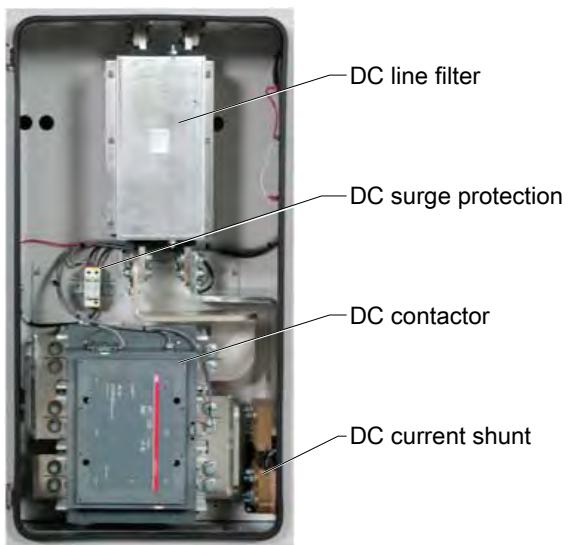


**Figure 2-5.** DC combiner sub panel

DC conductors from the array can enter through the side gland plate or through the collared chase in the base of the inverter.

## DC Sub Panel

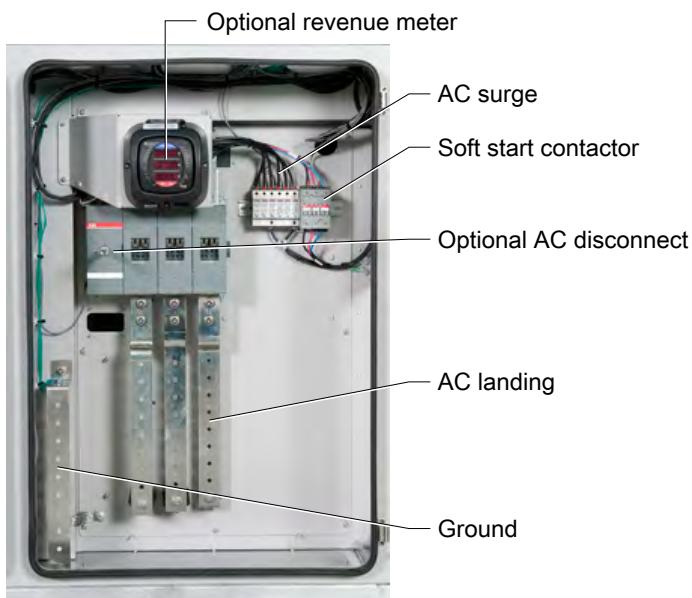
This lower middle compartment for the DC sub panel houses the DC line filter, DC contactor, DC surge protection, and DC voltage sense fusing.



**Figure 2-6.** DC sub panel

## AC Sub Panel

The AC landing, AC surge protection, soft start contactor and ground reside in the AC sub panel. The sub panel also includes the optional AC disconnect and revenue meter.



**Figure 2-7.** AC sub panel

## Housekeeping Transformer

The housekeeping transformer, located in the upper right in the control electronics compartment, is a voltage conversion device that transforms 480 VAC to 120/160 VAC for use within the inverter.

## Magnetics Compartment

The magnetics compartment contains the isolation transformer and the inductors.

- Isolation transformer: The inverter comes equipped with an integral isolation transformer. The isolation transformer is designed for class-leading inverter efficiency.
- Inductor: The inductor is used to filter the AC waveform generated by the power module, effectively reducing high frequency noise.



# Planning

## GENERAL REQUIREMENTS FOR PLANNING AND INSTALLATION

Planning for an installation of an AE inverter should only be performed by qualified engineers with a thorough understanding of the processes involved for a successful installation. Licensed and trained installers must comply with all local and national code requirements for the installation of electrical power systems with AC and DC voltages to 600 V.

The inverter must be anchored to a concrete mounting pad. The mounting pad must meet local seismic requirements. Refer to the mechanical drawings in this manual for optional seismic-rated concrete pad mounting requirements.

## HANDLING THE INVERTER



### WARNING:

Heavy equipment. AE 500 units weigh up to 4,140 kgs (9,100 lbs) with pallet and packaging. If the unit is lifted incorrectly, it may result in death. In addition, improper handling may result in serious damage to the unit and may also void the warranty. Keep all doors securely closed while moving the unit. Only use lifting equipment that is rated for the weight of the unit. Only use the specified lifting points.



### AVERTISSEMENT:

Équipement lourd. Les unités AE 500 pèsent jusqu'à 4,140 kgs (9,100 lbs) avec palettes et emballage. Tout levage inadéquat de l'unité peut provoquer la mort. De plus, toute manipulation inadéquate peut provoquer des dommages graves à l'unité et pourrait aussi annuler la garantie. Garder toutes les portes bien fermées lors du déplacement de l'unité. Utiliser uniquement un équipement de levage d'une capacité nominale convenant au poids de cette unité. Utiliser uniquement les points de levage spécifiés.

The inverter can weigh up to 4,140 kgs (9,100 lbs) with their pallet and packaging. If the inverter is improperly handled, serious damage can occur and the warranty may be voided. Only use lifting equipment that is rated for the weight of the inverter. Only use the specified lifting points. Leave the inverter on its shipping pallet with the protective plastic wrap in place until it is time to install.

**☞ Important**

Do not lift the inverter from the upper bolt points.

## Handling Options

The AE 500 inverter may also be moved using lifting bars inserted through the front to back fork slot openings.

**☞ Important**

Use only the front and rear fork slots. Do not use side slots to move the inverter.

## STORAGE

Prior to installation, the inverter should be stored in a non-condensing environment to avoid potential rust and corrosion. Remove the transport bag when the inverter is received. If the hood scoops are not installed, both hood scoops will need to be installed immediately.

## LOCATION AND CLEARANCES

### Location

Select a suitable location to install the inverter. The inverter must be installed on a flat, solid surface such as a concrete pad.

### Noise

The inverter is capable of emitting audible switching noise and should be located away from noise sensitive areas that are populated by people or animals.

### Recommended Clearances

Working clearances must comply with your national and local electrical code.

**Table 3-1. Inverter clearances**

Location	Distance	Description
Front	36"	The front clearance is required to open and maintain the unit or as required by local code.

**Table 3-1. Inverter clearances (Continued)**

Location	Distance	Description
Rear	24"	The rear clearance is required behind the inverter to allow room for full opening of the air intake hoods.
Sides	36"	The minimum side clearances are 36" in order open the side panels and work on internal components when necessary.
Top	27.5"	The top clearance is required above the air intake hoods to maintain the filters.

Clearances are shown in the figure below.

**Figure 3-1. Inverter clearances**

## CONDUIT AND CONDUCTORS

All the external conduit and conductors are to be supplied by the installer. All interconnect wiring and power conductors interfacing to the inverter must be in accordance with national and local electrical code. All conductors shall be rated for 90°C (minimum).

Large gauge wire must conform to the minimum bend radius specified by applicable national and local codes.

External cable interfaces are through bottom or side gland plates. The gland plates must be in place for operation of the inverter. Gland plate locations are included on the mechanical drawings in the appendix.

## ENVIRONMENTAL REQUIREMENTS

The unit may be installed either indoors or outdoors. If the installation of the inverter is outdoors, all interconnect conduit and fittings must be rated NEMA 4 (same as the inverter rating) as required by the NEC. For high temperature locations a shade structure should be placed over the unit in order to reduce thermal stress and extend the product's life.

Inverter power output will be de-rated for ambient temperatures in excess of 55°C/131°F.

*Table 3-2. Cooling and heat rejection rate requirements*

Requirement	Rate	Description
Cooling air flow rate (maximum)	3,800 CFM	No external intake or exhaust air ports are required in the building if air flow volume needs are met.
Heat rejection rate (maximum)	78,500 BTM/hr	n/a

## GROUNDING AND NEUTRAL REQUIREMENTS

### PV Array Frame Grounding



#### DANGER:

Do not connect the PV negative or positive conductors to the ground bus bars provided. The PV array is grounded through the integral GFDI. Connecting the PV array positive or negative conductors to ground at any other point in the system would defeat the ground fault protection circuit.

**DANGER:**

Ne pas brancher les conducteurs négatifs ou positifs du PV aux barres omnibus mises à la terre fournies. Le panneau photovoltaïque est mis à la terre au moyen du GFDI. La connexion des conducteurs positifs ou négatifs du panneau photovoltaïque à la terre à tout autre point du système pourrait déjouer le circuit de protection contre les défauts de terre.

**CAUTION:**

The inverter may be factory configured for either positive or negative ground. It may NOT be field configured to a different grounding once it is shipped from the factory. To identify if your inverter is configured for positive or negative ground read the label next to the DC landing bus bar. Verify that the grounding configuration matches your installation grounding plan. If you need to reconfigure the ground, contact Advanced Energy for assistance. DO NOT ground either DC lead at the time of installation. This will defeat the integral GFDI circuit.

**ATTENTION:**

L'inverseur peut être configuré à l'usine pour une mise à la terre positive ou négative. Il ne peut PAS être configuré sur le terrain à une mise à la terre différente une fois qu'il a été expédié de l'usine. Pour savoir si votre inverseur est configuré pour une mise à la terre positive ou négative, lire l'étiquette près de la barre omnibus CC. Vérifier que la configuration de mise à la terre correspond à votre plan de mise à la terre d'installation. Si on a besoin de reconfigurer la mise à la terre, contacter Advanced Energy pour de l'aide. NE PAS mettre à la terre le fil CC au moment de l'installation. Cela déjouerait le circuit GFDI.

The inverter incorporates an integral GFDI device. The PV array safety ground (frame ground) may be attached to the provided grounding bus bar. The grounding bus bar is located in the DC combiner sub panel compartment. The PV array is grounded internally by means of the GFDI.

The inverter is shipped preconfigured with positive or negative PV array grounding based on the preference specified when the order is placed.

## System Neutral

The inverter has been certified to national standards for installation without a neutral conductor. Do not connect a neutral conductor from the AC service panel to the inverter.

**WARNING:**

The AC output/neutral must not be bonded to ground within the equipment.



**AVERTISSEMENT:**

La sortie et le neutre CA ne doivent pas être branchés à la masse à l'intérieur du dispositif.

## UTILITY GRID INTERCONNECTION

### Utility Connection Requirements

Review all applicable national or local codes for specific requirements for the size of the electrical service and the amount of current that is allowed to be fed into the panel by the inverter.

### Contacting Your Local Utility

Contact your electrical utility before connecting the inverter to ensure there are no local restrictions or special requirements. Your local utility company may require specific inspections, equipment, or other procedures not covered in this document.

### Voltage Output

This inverter is designed to be connected to a three phase, grounded, wye transformer. The AC output voltage is available on the inverter data plate for the output voltage wye configuration. Do not change the output voltage of the inverter. AC and DC power requirements are included in the specifications.

#### Related Links

- “Specifications” on page 9-1

## INVERTER MONITORING

The inverter is equipped with a data monitoring module that can be used to monitor the inverter through one of the following interfaces:

- Basic performance data can be accessed using a free web-based monitoring service provided by AE.
- Locally through a third party monitoring system using Modbus/TCP or Modbus/RTU.

### Related Links

- “Data Monitoring and Controls” on page 6-1

## CALCULATING DC INPUT VOLTAGE

### To Calculate Maximum Open Circuit Voltage

- Calculate the maximum open circuit (no load) voltage for each series module connection. Refer to the Advanced Energy Solar Energy web site and select the **String Calculator** to calculate the input from the PV array.

Contact AE Solar Energy Technical Support if you require assistance calculating the maximum DC input voltage for your array at your specific location.



#### Important

Each DC input connection must be wired to deliver the same input voltage.



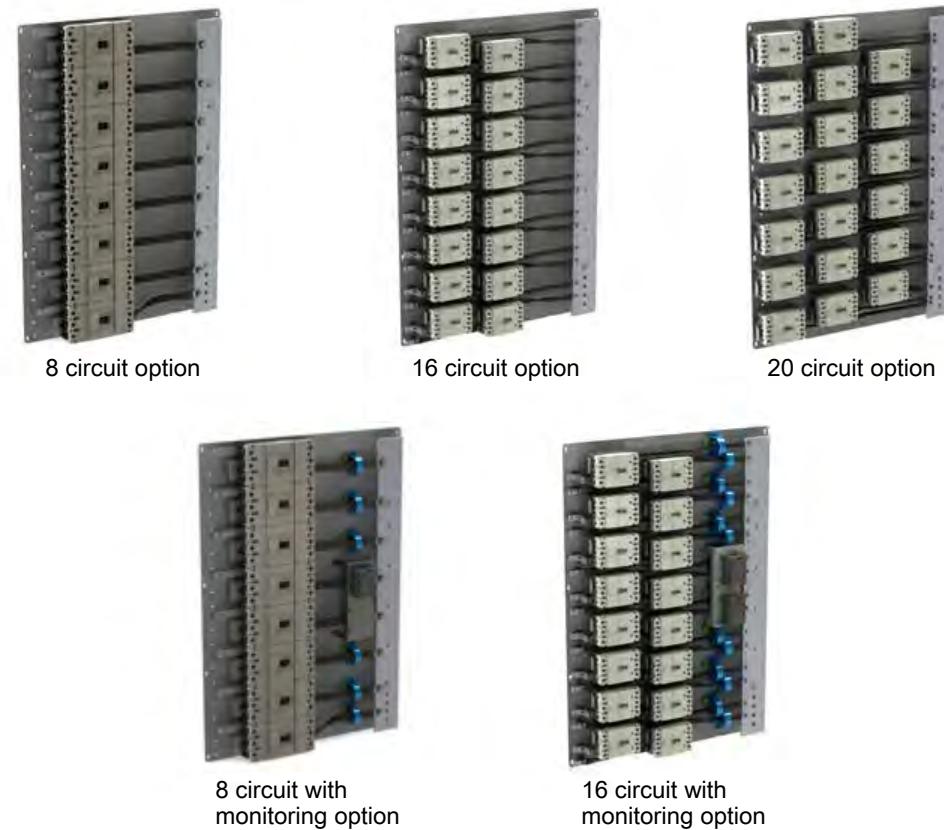
#### Important

For all temperature conditions, the open circuit voltage for each series connection must be less than or equal to 600 VDC.

## DC COMBINER SUB PANEL OPTIONS

The inverter comes with standard positive and negative bus bars for landing DC inputs from the PV array.

An optional DC circuit breaker subcombiner can be factory installed. Standard configurations include 8, 16, or 20 DC circuit breaker configurations are available as shown in the figure below. Monitoring can be included on the 8 and 16 circuit breaker configurations.



*Figure 3-2. DC subcombiner options*

## Breaker Protection for DC Input

The installer is responsible for providing proper over current protection for the DC input circuit if the subcombiner circuit breaker option is not included.

# Installing

## HANDLING AND UNPACKING

This section describes the required safe handling and unpacking procedures for the AE inverter. Always follow the recommendations in this section to prevent accidental damage or injury.



### WARNING:

**Heavy equipment.** AE 500 units weigh up to 4,140 kgs (9,100 lbs) with pallet and packaging. If the unit is lifted incorrectly, it may result in death. In addition, improper handling may result in serious damage to the unit and may also void the warranty. Keep all doors securely closed while moving the unit. Only use lifting equipment that is rated for the weight of the unit. Only use the specified lifting points.



### AVERTISSEMENT:

**Équipement lourd.** Les unités AE 500 pèsent jusqu'à 4,140 kgs (9,100 lbs) avec palettes et emballage. Tout levage inadéquat de l'unité peut provoquer la mort. De plus, toute manipulation inadéquate peut provoquer des dommages graves à l'unité et pourrait aussi annuler la garantie. Garder toutes les portes bien fermées lors du déplacement de l'unité. Utiliser uniquement un équipement de levage d'une capacité nominale convenant au poids de cette unité. Utiliser uniquement les points de levage spécifiés.

## Packaging Contents

The following items are included with the inverter when it is packaged for shipping:

- Manual
- Warranty card
- Final test report
- Keys for door handles

## Handling and Unpacking the Inverter

### TOOLS REQUIRED

- Two 3/4" wrenches or one wrench and one 3/4" socket wrench

- Lifting device such as a forklift or pallet jack
- Utility knife

The inverter can be moved using a forklift or pallet jack that is rated to handle a minimum of 4,140 kgs (9,100 lbs).

## TO UNLOAD AND UNPACK THE INVERTER

1. Lift and move the inverter using the shipping pallet.  
Do not penetrate the packaging or use the inverter base for unloading.
2. Remove the protective plastic wrap encasing the inverter.  
If no damage is apparent, proceed with the next step. If you do see signs of shipping damage, contact AE Solar Energy Technical Support and the carrier immediately.
3. Using a 3/4" wrench, loosen the bolts and nuts securing the inverter to the pallet.

## Installing the Air Intake Hoods

The air intake hoods may ship in separate packaging from the inverter. If the air intake hoods are separate, both air intake hoods must be installed as soon as the protective blue shipping wrap is removed from the inverter. The air intake hoods prevent water and foreign objects from entering the inverter cabinet.

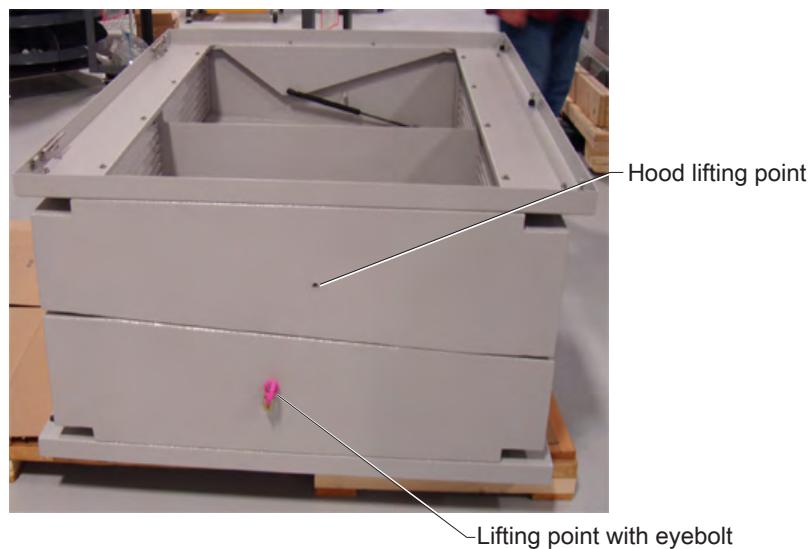
## TOOLS REQUIRED

- Lifting device such as a forklift or overhead crane
- Lifting strap or chain
- Spreader bar
- Eyebolts
- Utility knife
- Flat head screwdriver

## TO INSTALL THE AIR INTAKE HOODS

The air intake hoods are installed one at a time. After completing these steps for the first hood, repeat the steps for the second hood.

1. Unstack the air intake hoods and set them side by side.



**Figure 4-1.** *Stacked air intake hoods*

2. Insert eyebolts through the lifting point holes on each end of one air intake hood. Secure the eyebolts.
3. Connect a lifting strap securely to each eyebolt.

 **Important**

Use a spreader bar to prevent the lifting straps from crushing the air intake hood.

4. Lift the air intake hood using the eyebolt as the lifting point.

 **Important**

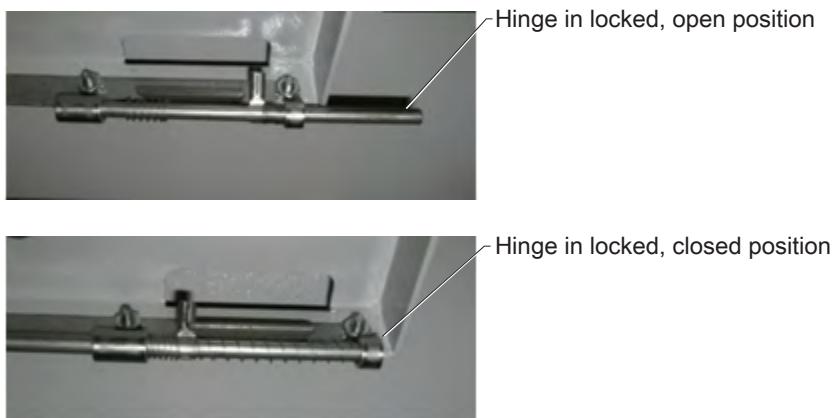
Lift the air intake hood from the proper hoisting points only. Each hood weighs 40 pounds.

As the air intake hood clears the ground, the hood rotates on the eyebolts, settling into a correctly oriented position for installation. Carefully guide the hood with your hands, if necessary, to prevent the hood from swinging.



**Figure 4-2.** Placing the air intake hood on the inverter

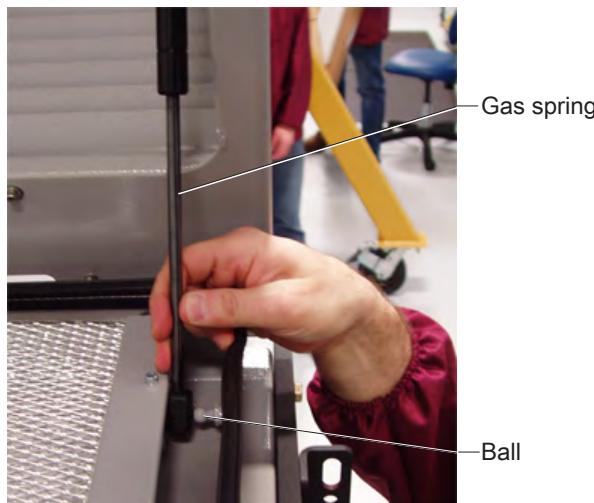
5. Set the two back hinges on the rear edge of the air intake hood, on the rear top edge of the inverter cabinet while aligning the hinge barrels.
6. Rotate the tab on each hinge to unlock the pin. Slide the pin into the cabinet side of the hinge barrel and lock into place by rotating the tab. This secures the back hinges.



**Figure 4-3.** Hinge on the air intake hood - locked and open positions

7. Remove the tape from the unattached end of the gas springs.  
The other end of the gas springs are factory installed to the air intake hood.
8. Lower the loose end of the gas springs to the cabinet and snap into place on the ball on the inside of the inverter cabinet.

Once the gas springs are attached to the cabinet, they will hold the hood open.



**Figure 4-4.** Attaching the hood's gas springs to the inverter

9. Remove the lifting strap and the eyebolts from the installed air intake hood.
10. Close the air intake hood.
11. Using a slotted screw driver, engage all three latches, by rotating clockwise, to secure the front edge of the air intake hoods. Align the two dimples on the latch bezel to ensure a tight seal.



**Important**

The first air intake hood must be securely latched and the eyebolts removed before installing the second hood.

## PRE-INSTALLATION INSPECTION

Before placing and installing the inverter, the inverter should be inspected to identify possible external and internal shipping damage. If a problem is identified during any of these inspection steps contact AE Solar Energy Technical Support.

### Pre-Installation Inspection Tools

The following tools are needed to perform the pre-installation inspection of the inverter:

- Large flat blade (common) screwdriver
- Access door entry key
- Hex wrench

## Step 1: External Inspection

1. Inspect the shipping materials and the inverter for any cosmetic or structural damage. Specifically look for any structural damage or crushing of the base or doors.
2. Confirm all doors open freely and easily.

The front doors on the main compartments of the inverter have a rotating hand latch with integral key lock to secure the main compartment doors. All other access doors on the inverter require that a flat blade screwdriver latch be released in order to open the doors.

 **Important**

If the DC circuit breaker option is included, the DC sub panel compartment will not have a locking door.

## Step 2: Inspection of Rear Magnetics

1. Using a hex wrench remove the large cover plates on the back of the inverter to access the magnetics.
2. Inspect all nine connections including the following:
  - a. Three into the inductors
  - b. Three from the inductors to the transformer

For each connection check the integrity of the bus bar connections and terminals.

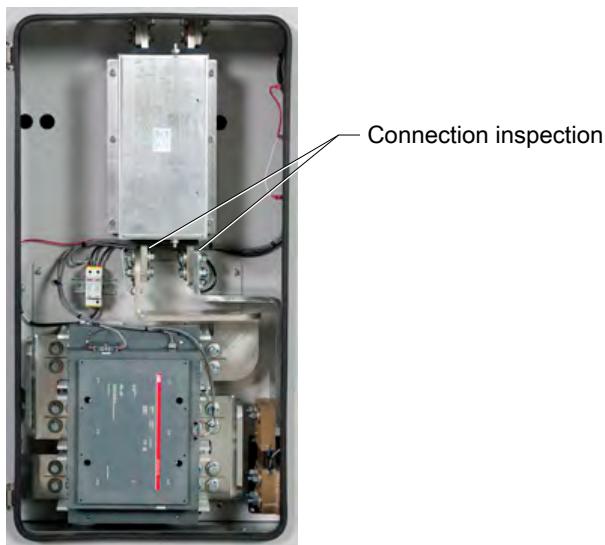


*Figure 4-5. Inductor and transformer connections*

3. Check the screens at the bottom of the compartment for damage or debris.
4. Replace the cover plates. Make sure the gaskets are not damaged during replacement of the plates. Do not overtighten the screws.

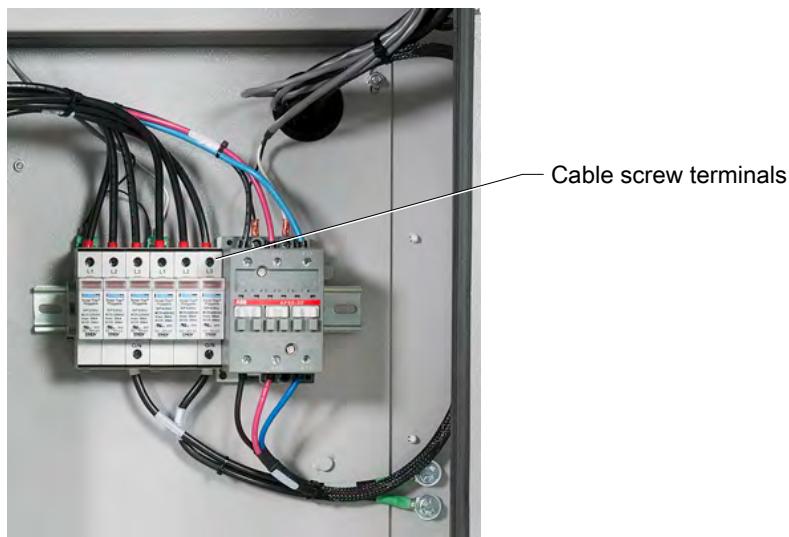
## Step 3: AC and DC Sub Panel Compartments

1. Check the integrity of the bus bar connections and terminals for each bus bar landing in the AC and DC compartments.



*Figure 4-6. Bus bar connection inspection*

2. Ensure the cable connections are plugged in and fully seated.
3. Inspect and pull test all cable screw terminal connections.



**Figure 4-7.** Pull test of cable screw terminal connection

4. Inspect the screens at the bottom of the compartment for damage or debris.

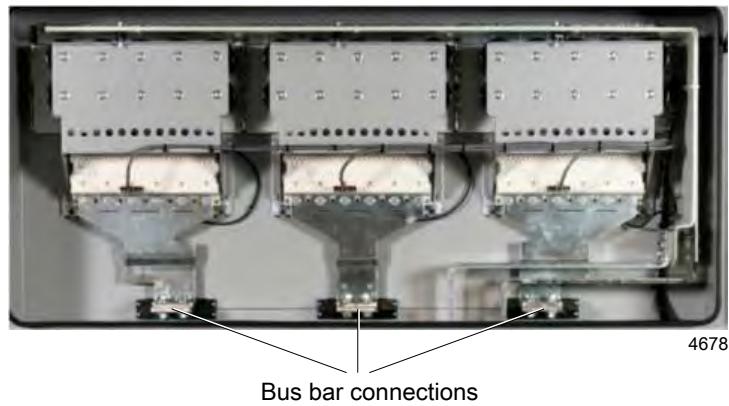


**Figure 4-8.** Screen inspection

If any loose wires are found during the inspections, and the correct location of the connection is unknown, contact AE Solar Energy Technical Support.

## Step 4: Power Module Compartment

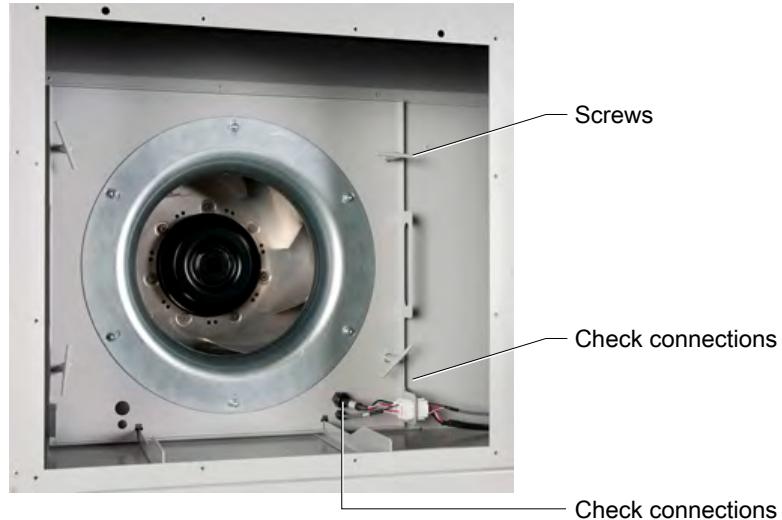
- Check the integrity of the bus bars and their connections in the upper power module compartment.



*Figure 4-9. Check the bus bar connections*

## Step 5: Upper Active Cooling Compartment

1. Ensure the fans spin freely.



*Figure 4-10. Fan inspection*

2. Ensure all air filters are fully seated.



**Figure 4-11.** Air filter check

This completes the pre-installation inspections.

## LIFTING AND MOUNTING THE INVERTER

The inverter base is designed to allow a properly rated forklift to lift it from the front or back using the fork slots.



### Important

Before installing the inverter, make sure the pre-installation inspection steps have been completed and no issues have been identified.

## Mounting Requirements

When mounting the inverter, consider the following requirements:

- Mount the unit on a flat surface in an upright position.
- The mounting surface must comply with all national and local standards for weight, seismic, and wind sheer requirements.
- The mounting surface must be prepared according to the site specific structural drawing.

## Required Tools

- Lifting device such as forklift or a crane may be used to lift and position the inverter. Lifting devices must be rated for 4,140 kgs (9,100 lbs). Proper lifting methods may include:
  - Using a crane with a strap rated for the weight of the inverter

- Using lifting beams, spreader bars, or similar equipment rated for the weight of the inverter

## To Lift and Mount the Unit



### **WARNING:**

Do not attempt to lift the full weight of the unit from the left or right sides only. Attempting to lift from just the left or right sides only will result in an unstable and unsafe condition.



### **AVERTISSEMENT:**

Ne pas tenter de soulever l'unité uniquement à partir du côté gauche ou droit. Toute tentative de soulever l'unité par le côté gauche ou droit pourrait occasionner une situation d'instabilité dangereuse.



### **CAUTION:**

Care **MUST** be taken to protect the inverter from compressive stresses or forces which may dent or deform the cabinet or cause damage to the inverter. Damage caused by improper handling may void the warranty. Safe handling, operating, and installation practices are the responsibility of the installer.



### **ATTENTION:**

Redoubler de vigilance pour protéger l'inverseur des contraintes ou forces en compression qui peuvent endommager ou déformer l'armoire ou endommager l'inverseur. Les dommages causés par la manipulation inadéquate peuvent annuler la garantie. Les pratiques sécuritaires de manipulation, de fonctionnement et d'installation incombent à l'installateur.



#### **Important**

Damage caused by improper handling can void the warranty. Safe operating, handling, and installation practices are the responsibility of the installer.

1. Prepare the mounting surface according to the site specific structural drawing.
2. Remove the plates covering the fork slots.
3. Lift the inverter off the pallet using the forklift slots on the front or back.

The front and back of the inverter base each have two fork slots that are 8.5" wide and 34" apart on center.



#### **Important**

The center of gravity is toward the back, lower third of the inverter and centered side to side. Refer to the mechanical drawings to view the center of gravity location.

4. Position the inverter in the selected location.

Alternate methods of lifting and positioning the inverter may be used. Proper methods may include the use of a crane with a strap rated for the weight of the inverter; however, care MUST be taken to protect the inverter from compressive stresses or forces which may dent or deform the cabinet or cause damage to the inverter. Use of lifting beams, spreader bars, or similar equipment rated for the weight of the inverter can be employed for this purpose.

5. Secure the inverter to the mounting surface by setting the anchoring hardware through each of the six holes in the external mounting flange on the base of the unit.

Refer to the mechanical drawings in the Appendix to review the anchoring locations.

6. Replace the cover plates over the fork slots.

## CONDUIT ENTRY POINTS

The inverter is shipped from the factory with side and bottom gland plates that allow for conduit entry.

 **Important**

All penetrations in the inverter cabinet must be through the specified gland plates which are for the sole purpose of providing a safe and convenient way to route wiring in to and out of the inverter. Penetrating the inverter housing in any other location besides the gland plates voids the warranty.

 **Important**

Do not block the cabinet's side access with conduit.

 **Important**

Do not attach conduit support structure to the cabinet.

The bottom of the inverter has collared entry conductor chases available in the DC and AC landing compartments. The bottom left side gland plates can be removed to expose the chases as an alternative to the gland plates.

## Using Gland Plates for Cable Conduit Entry and Exit

All power cabling and communications wiring must enter and exit via the inverter cabinet's gland plates. There are gland plates on the AC and DC sides of the inverter for bottom and side entry. In addition, there is a gland plate on the upper left side for data monitoring wiring. Each gland plate location is selected to ensure safe installation, proper airflow and prevention of dust, debris, moisture, insect, and animal incursion. Do not penetrate the cabinet at any other location. All gland plates except those covering the bottom entry chases need to be installed for proper operation of the inverter.

The bottom chases are located beneath the bottom DC and AC gland plates. If the bottom side chase is used, the bottom DC and AC gland plates are not needed and can be removed from the cabinet. The gland plates should not be left loose in the compartment.

 **Important**

The gland plate on the front of the inverter, next to the DC combiner sub panel door, is intended for service access only and should not be used for conductor entry.

## TOOLS REQUIRED

- 5/32" hex wrench
- NEMA 4 conduit hubs
- Knockout punch

## TO USE THE GLAND PLATES

 **Important**

All penetrations in the inverter cabinet must be through the gland plates which are provided for the sole purpose of a safe and convenient way to route wiring in to and out of the inverter. Penetrating the inverter cabinet in any other location besides the gland plates voids the warranty.

 **Important**

Remove all metal shavings and wire scraps from the inverter prior to replacing the gland plates.

1. Select the size(s) and location(s) of the hole(s) that need to be punched.



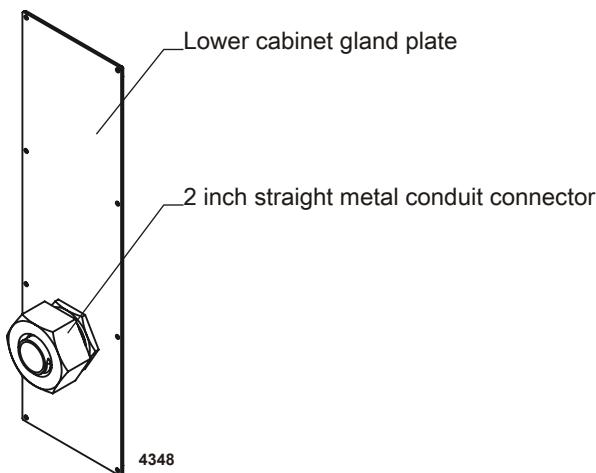
**Figure 4-12. DC bottom entry gland plates**



**Figure 4-13. DC side entry gland plates**

2. Remove the gland plate while taking care not to damage the weatherproof gasket material on the back side of the plate.
3. Punch holes as needed in the gland plate.
4. Attach watertight NEMA 4 conduit hubs in each hole.

The inverter is a NEMA 4 enclosure. Use only rain-tight or wet-location conduit hubs and install these hubs as shown in the following figure.



**Figure 4-14. Installation of conduit hub**



**CAUTION:**

For outdoor installations make liquid-tight connections to the unit.



**ATTENTION:**

Pour les installations extérieures, effectuer des connexions étanches à l'unité.

5. Replace the gland plate taking care to evenly seat the gasket material against the cabinet.
6. Tighten until the gland plate is snug. Do not overtighten.

## ELECTRICAL CONNECTIONS

**DANGER:**

Electrical connections must comply with national and local standards. Voltage drop and other considerations may dictate that larger wire sizes be used.

**DANGER:**

Les connexions électriques doivent être conformes aux normes nationales et locales. Des chutes de tension et autres facteurs peuvent imposer l'usage de fils de plus gros calibre.

**DANGER:**

**RISK OF DEATH OR BODILY INJURY.** Disconnect and lockout/tagout all sources of input power before working on this unit or anything connected to it.

**DANGER:**

**RISQUE DE MORT OU DE BLESSURES CORPORELLES.** Débrancher et verrouiller/étiqueter toutes les sources de puissance d'entrée avant de travailler sur cette unité ou sur tout élément qui y est raccordé.

After the inverter is properly secured to the mounting pad and the conduit hubs have been installed the electrical connections can be completed. Terminal connections for the inverter are located inside the inverter. When facing the inverter the connections are located in the following areas:

- DC terminals are on the left side
- AC terminals are on the right side

Both AC and DC bus bars accept standard terminal lug-crimped wires mounted to the bus bar fittings with standard grade 8, 3/8" mounting hardware.

For the optional DC circuit breaker subcombiners, the conductor is connected to the bus bar provided for each breaker or inserted directly into the DC circuit breaker frame depending on the configuration. The following table lists the accepted wire sizing for each subcombiner lug option.

**Table 4-1. Subcombiner wire sizing and torque values**

Breaker Frame Maximum Amperage	Maximum Wire Size	Required Torque	Terminal Temp. Rating
8 x 400	Direct to bus bar. No wire size limit. Attach lug to bus bar with grade 8, 3/8" hardware.	40 ft-lbs	90°C
16 x 225	Direct to bus bar. No wire size limit. Attach lug to bus bar with grade 8, 3/8" hardware.	40 ft-lbs	90°C
20 x 225	4/0 max, #4 min Cu/AL	10 ft-lbs	75°C
No DC breakers	Direct to bus bar. No wire size limit. Attach lug to bus bar with grade 8, 3/8" hardware.	40 ft-lbs	75°C

## AC Wiring



### WARNING:

Follow the order listed in this section to wire the inverter. Failure to do so may result in hazardous voltages or disconnection of contacts.



### AVERTISSEMENT:

Pour câbler l'onduleur, suivez les ordres décrits dans cette section. Tout manquement au suivi scrupuleux des instructions est susceptible d'entrainer des tensions anormales ou le débranchement de contacts.



### CAUTION:

To reduce the risk of fire, connect only to a branch circuit with overcurrent protection appropriately rated in accordance with your national and local electrical codes.



### ATTENTION:

Pour réduire le risque d'incendie, brancher seulement à un circuit de dérivation avec une protection de surintensité d'une capacité nominale conforme aux codes d'électricité nationaux et locaux.

**CAUTION:**

The input and output circuits are isolated from the enclosure. System grounding, when required by national and local electrical code, is the responsibility of the installer.

**ATTENTION:**

Les circuits d'entrée et de sortie sont isolés de l'enceinte. La mise à la terre du système, lorsqu'elle est exigée par le code d'électricité national ou local, est la responsabilité de l'installateur.

**WARNING:**

The AC output/neutral must not be bonded to ground within the equipment.

**AVERTISSEMENT:**

La sortie et le neutre CA ne doivent pas être branchés à la masse à l'intérieur du dispositif.

**Important**

The inverter is certified for installation without a neutral conductor. Do NOT pull a neutral conductor from the AC service panel to the inverter.

The inverter is designed for use with the following grounded wye, three-phase power grids.

- 480 VAC

**Important**

The inverter must be connected to a grounded wye configuration.

The voltage output is not selectable on AE inverters. Do not attempt to change the AC output voltage once it is set at the factory.

Use the applicable national and local electrical code to select the appropriate AC wire sizing for your application. Correct wire sizing requires, at a minimum, considerations for ampacity, temperature, and conduit. In addition, wire should be sized to minimize voltage drop. Install the inverter on a dedicated branch circuit with a recommended circuit breaker rating as specified in the following table.

**Table 4-2. Branch breaker size recommendations**

Model	208 VAC	480 VAC	600 VAC
AE 500	N/A	800 A	N/A

The inverter does not have internal AC fusing so it is important to size the branch circuit protection appropriately.

When an inverter is installed on an electrical panel the AC operating voltage range of the inverter should be considered. Voltages outside this range will cause the inverter to fault. See the specifications section of this manual for AC operating voltage ranges.

**Table 4-3. Operational voltage ranges per electrical panel**

Electrical Panel	Operational Voltage Range
480 VAC	422 VAC – 528 VAC

### Related Links

- “Electrical Specifications” on page 9-1

## CONNECTING TO THE ELECTRICAL GRID



### DANGER:

Risk of electrical shock. High voltages are present in the inverter cabinet. Both AC and DC disconnects must be in the OFF position when working on the unit. Wait five minutes to discharge high voltage before opening the front panels of the inverter.



### DANGER:

Risque d'électrocution. L'intérieur de l'onduleur est soumis à des hautes tensions. Les interrupteurs de courant alternatif et continu doivent être mis HORS TENSION durant les travaux sur l'unité. Attendez cinq minutes afin de permettre la décharge du courant haute tension avant de démonter les panneaux avant de l'onduleur.



### CAUTION:

To avoid an increase in AC voltage to unacceptable values while the inverter is connected, the grid impedance value at the connection point should be as low as possible. By keeping the grid impedance value low, the system will achieve higher efficiency.



### ATTENTION:

Afin d'éviter des surtensions inacceptables de CA lorsque l'onduleur est branché, assurez-vous que la valeur de l'impédance aux points de connexion au réseau public est la plus basse possible. Une faible valeur d'impédance permet un fonctionnement plus efficace de l'appareil.

**WARNING:**

Do not connect a neutral wire to the WYE point of the isolation transformer. Doing so will cause the inverter to malfunction and will void the warranty.

**AVERTISSEMENT:**

Ne branchez pas de câble neutre au point WYE du transformateur d'isolation. Un tel branchement causerait un fonctionnement défectueux de l'onduleur et annulerait la garantie.

The inverter is connected to the electrical grid using four wires:

- Phase A voltage
- Phase B voltage
- Phase C voltage
- Ground

**Important**

Do NOT connect a neutral wire to the wye point of the isolation transformer.

The four AC termination bus bars for phases A, B, C, and ground are located in the lower section of the AC panel. The phase and ground bus bars are vertically mounted. Each bus bar has eight holes per phase of 3/8" diameter holes, spaced 1.625" apart vertically.

The AC connections must be made through conduit installed in the bottom or side entry gland plates.

**Tools Required**

- 5/32" Allen wrenches (Allen wrench adaptor for a socket wrench recommended)
- 7/16" open-end wrench or socket wrench and a 6" extender
- Torque wrench

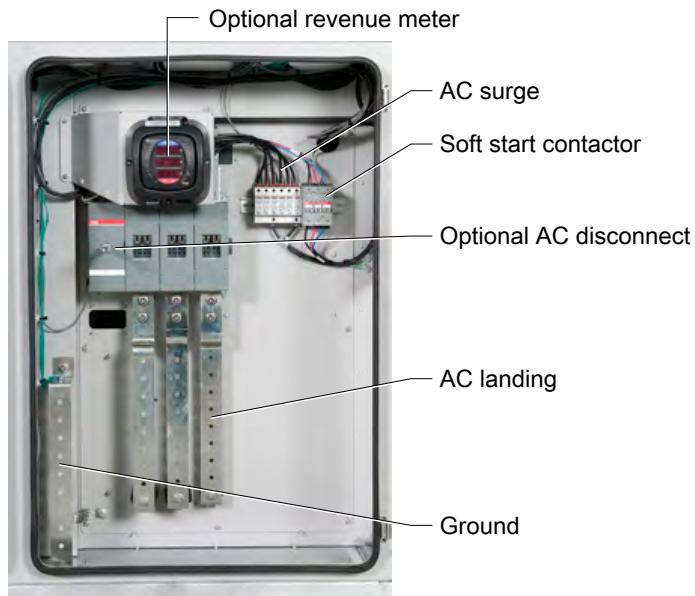
**To Connect the AC Wiring**

1. Remove the protective plastic cover with a 7/16" socket wrench.
2. Run the conduit from the main breaker panel to the desired gland plate on the inverter.
3. Insert a conduit fitting in the gland plate and fasten with a locking nut.
4. Feed the PHASE A, PHASE B, PHASE C, and GROUND wires through the conduit and into the right side conduit opening of the inverter.
5. Connect the wires to the appropriate AC landings as follows:
  - a. GROUND wire to the marked **EARTH GROUND** landing inside the inverter.

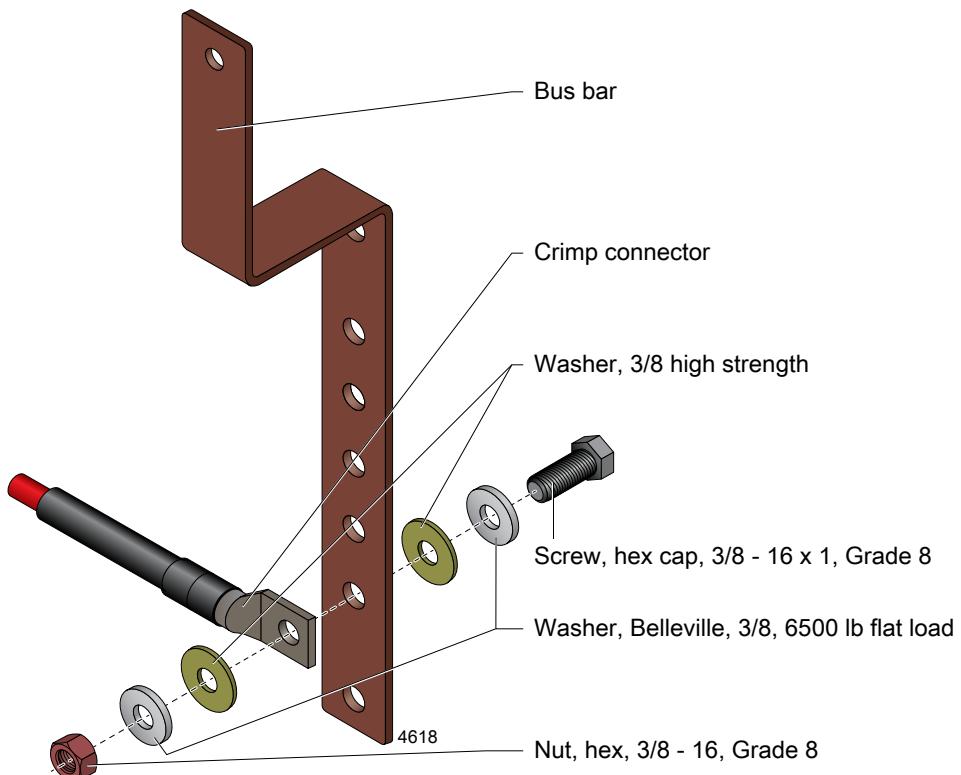
b. Phase A, B, and C to the AC landings inside the inverter.

 **Important**

The inverter auto phases and will auto detect phase rotation.



*Figure 4-15. AC connections*



*Figure 4-16. Bus bar connections*

Use grade 8, 3/8" hardware to secure the lugs of the outgoing AC cables to the bus bars.

6. Ensure all connections are wired correctly and properly torqued. Tighten the AC terminal screws to 40 ft-lbs.
7. Reinstall the protective plastic cover.

## DC Wiring



### DANGER:

Before proceeding with the DC wiring, confirm that the PV array has been disconnected from the inverter using the external DC disconnect.



### DANGER:

Avant d'effectuer les branchements CC, assurez-vous que les piles PV sont déconnectées de l'onduleur en utilisant le connecteur CC externe.



### DANGER:

Make sure the PV array polarity and voltage between the positive and negative cables are correct before connecting the PV array cables to the DC terminal block.



### DANGER:

Assurez-vous que la polarité et le voltage des câbles positifs et négatifs des piles PV sont corrects avant de brancher les câbles des piles PV aux bornes CC.

The DC negative and ground bus bars are located in the lower left compartment, the DC landing to the left of the DC combiner sub panel. The DC positive and optional DC circuit breaker subcombiner are located in the DC combiner sub panel. The positive, negative, and ground bus bars are vertically mounted. The positive and negative bus bars have 18 rows of two 3/8" diameter holes spaced 1.75" apart and four individual holes spaced 1.5" apart vertically. The ground bar has 24 rows of two 3/8" diameter holes spaced 1.25" apart.

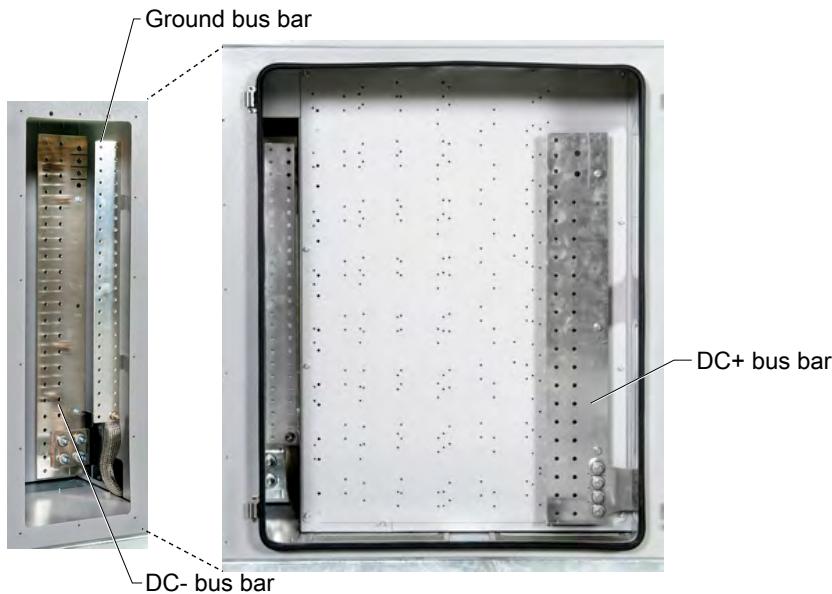


Figure 4-17. DC connections

## CONNECTING TO THE PV ARRAYS



### DANGER:

Risk of electrical shock. When exposed to light, PV arrays create electrical energy that could cause a hazardous condition.



### DANGER:

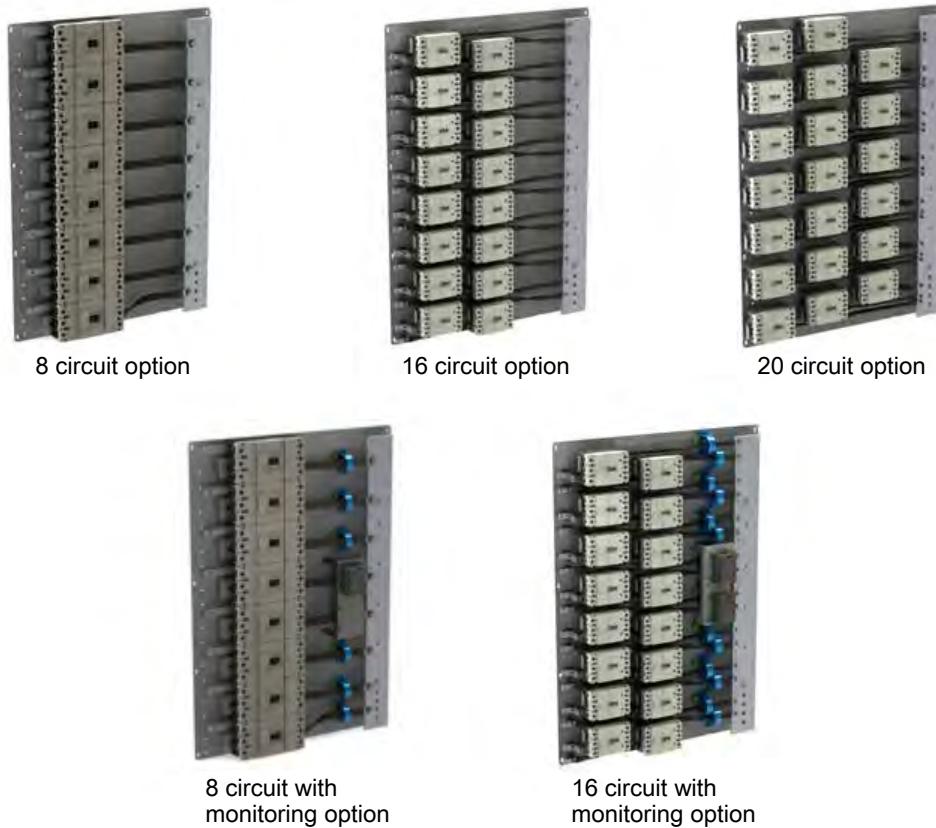
Risque d'électrocution. Lorsqu'elles sont exposées à la lumière, les piles photovoltaïques génèrent un courant électrique susceptible de causer des conditions dangereuses.

Follow these steps to wire the DC inputs from the PV panels to the inverter. These instructions are for a negatively grounded array. For a positively grounded array, use the opposite terminals.

### Tools Required

- 5/32" Allen wrenches (Allen wrench adaptor for a socket wrench recommended)
- Open-end wrench or socket wrench
- Torque wrench
- Voltmeter

### To Connect the DC Wiring



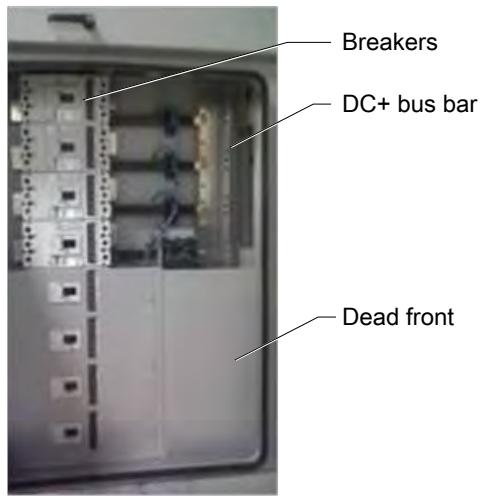
**Figure 4-18.** DC subcombiner configurations

1. Disconnect power to the DC wiring by disconnecting the PV array outside the inverter before starting the DC wiring.
2. Clearly mark the array positive and negative leads.
3. Route the PV array leads through the conduit to the desired entry gland plate on the DC side of the inverter.

 **Important**

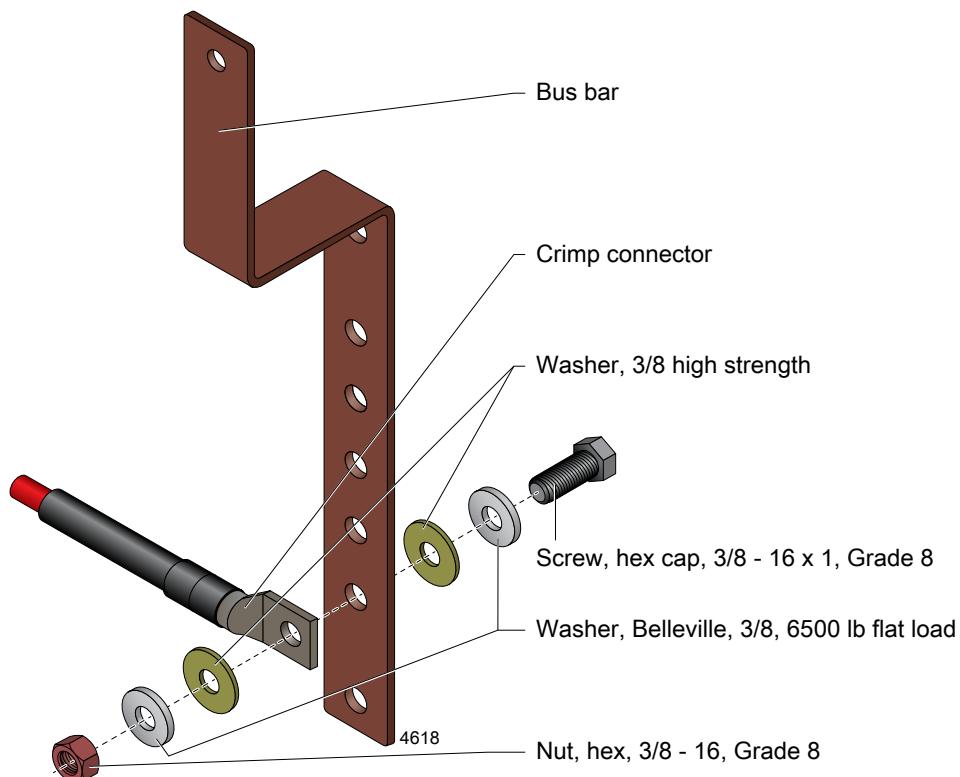
The front left access cover can be removed for better access to the DC wiring.

4. If using the DC circuit breaker option, remove the dead front panel to access the breaker landings.



**Figure 4-19. DC dead front**

5. Connect the PV frame ground wire(s) to the ground lug on the point marked  in the lower left side of the cabinet.
6. Connect positive DC cables(s) to the terminals located on the positive bus bar or the breaker by inserting the cable directly into the breaker frame terminal depending on the configuration. Use grade 8, 3/8" hardware to secure the lugs of the incoming DC cables to the bus bar. The DC landing torque specification is 40 ft-lbs.
7. Connect negative DC lead(s) directly to the terminals located on the negative DC bus bar as shown in the following figure. Use grade 8, 3/8" hardware to secure the lugs of the incoming DC cables to the bus bar. The DC landing torque specification is 40 ft-lbs.



**Figure 4-20.** DC inverter connections

8. Re-install the DC dead front if the circuit breaker option is used.
9. Energize the DC cables.
10. Using a voltmeter, check the PV array positive leads and confirm the voltage is positive when referenced to the negative leads. The reading should not exceed your calculated series Voc or the 600 VDC maximum inverter input specification.
11. De-energize the DC cables.
12. Re-install the front left access cover.

## Using the Integrated Remote Disable Input

There are two remote disable inputs available to the installer in the inverter. The inputs are located on the communications interface PCB which is located in the data monitoring compartment.

The remote disable inputs consist of two pairs of screw terminals to which a user can connect separate remote switches or contacts. Using the remote disable input allows the inverter to be shut down remotely by opening a switch or set of contacts. This feature would typically be used in conjunction with a fire alarm panel or a generator output signal. The contacts need to be normally closed for the inverter to operate. The customer will need to provide a 5 V, 5 mA tolerant relay, switch, or set of contacts.

**☞ Important**

Termination switches are located on the communications PCB terminal to allow normal operation. Do not move the switches unless you intend to use this feature.

**☞ Important**

Closing the remote disable contact with the inverter ON/OFF switch in the **ON** position will re-start the inverter.

## MAKING THE REMOTE DISABLE CONNECTION

### Parts or Tools Required

You need the following parts and/or tools to make the remote disable connection:

- Control wire, 14-22 awg
- Wire stripper
- Small screwdriver

**☞ Important**

Thin stranded wire is recommended.

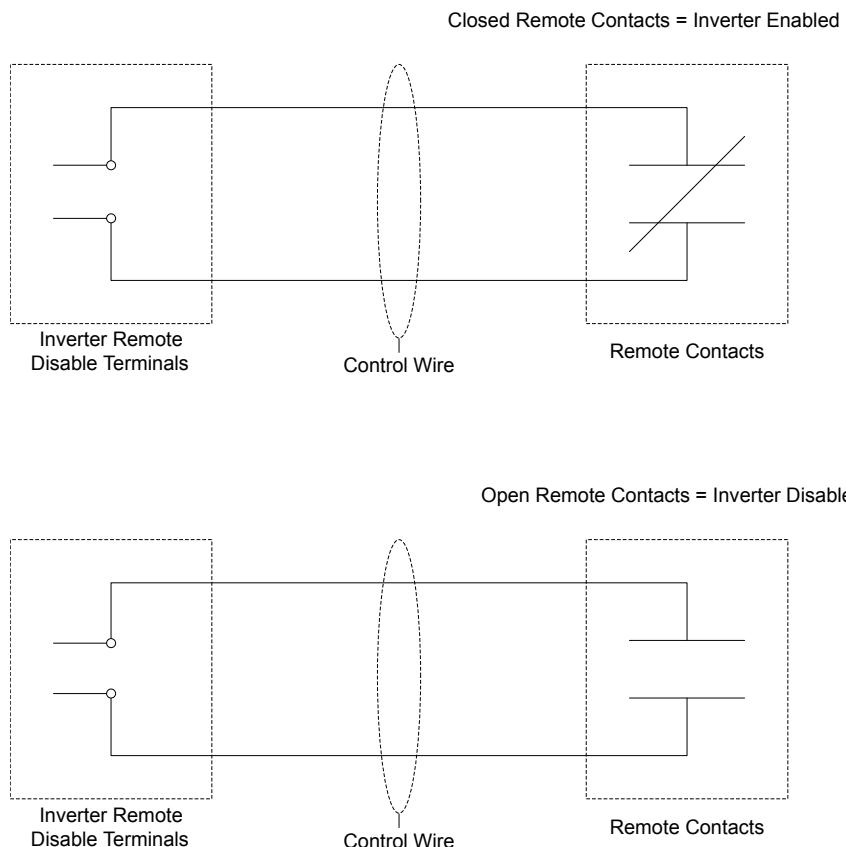
### The Remote Disable and Other On-Site Power Sources

The following information describes how to make the remote disable connection on the AE 500 inverter. The remote disable circuit requires a normally-closed contact capable of switching a 5 V, 5 mA signal. One or two remote disable connections can be made to the unit.

**☞ Important**

The AE 500 inverter cannot operate with this remote disable open. If the remote disable feature is not used, the remote disable termination switches must be left in place for the inverter to operate.

You are required to establish this external remote disable connection if an additional power source exists at your installation site that could be damaged if the PV system continues to run when the power source turns on. For example, if you have an on-site generator that supplies power when an electrical outage occurs, you should make the remote disable connection from the inverter to the on-site generator to ensure the PV system shuts down when the generator turns on.



*Figure 4-21. Remote disable wiring diagram*

### To Make the Remote Disable Connection



#### DANGER:

Risk of electrical shock. High voltages are present in the inverter cabinet. Both AC and DC disconnects must be in the OFF position when working on the unit. Wait five minutes to discharge high voltage before opening the front panels of the inverter.



#### DANGER:

Risque d'électrocution. L'intérieur de l'onduleur est soumis à des hautes tensions. Les interrupteurs de courant alternatif et continu doivent être mis HORS TENSION durant les travaux sur l'unité. Attendez cinq minutes afin de permettre la décharge du courant haute tension avant de démonter les panneaux avant de l'onduleur.



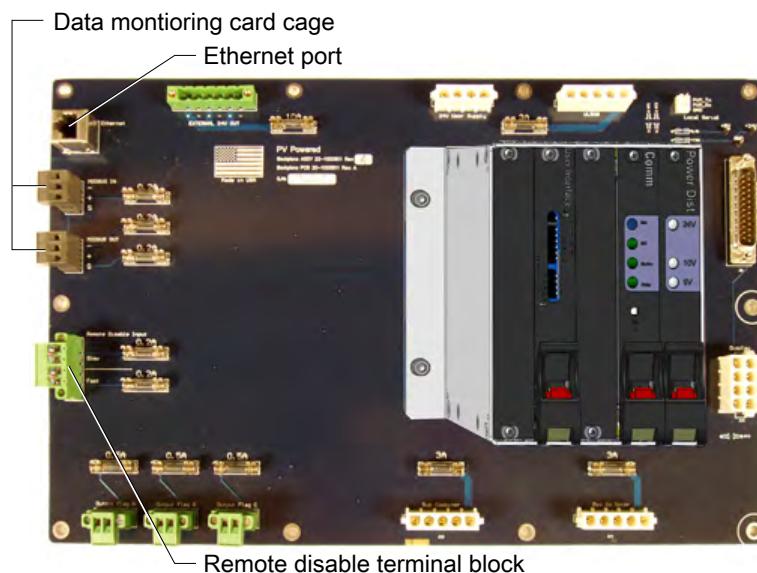
#### Important

This procedure is written for a single remote disable connection. If two remote disables are used, follow the same steps for each remote disable connection.

1. Disconnect the power to the inverter before starting the installation.
2. Remove the data monitoring gland plate on the upper left side of the inverter.

The data monitoring gland plate is a small, flat piece of metal covering the side entry port to the inverter's data monitoring compartment.

3. Drill or punch a hole in the desired location to allow access for the remote disable control wires.
4. Install a water-tight conduit hub connection.
5. Replace the gland plate.
6. Route the remote disable control wires from the remote device.
7. Locate the remote disable terminal block located on the communications interface PCB in the monitoring compartment.
8. Locate and remove one jumper from the remote disable terminal block shown in the following illustration.



**Figure 4-22.** *Remote disable terminal block*

9. Strip approximately 1/4" (6 mm) of insulation from each conductor of the control wire.
10. Insert the stripped wires in the remote disable terminal block and tighten the screws.

## 24 V Power Supply

The AE 500 inverter has an integrated 24 V power supply option. The 24 VDC power supply is sized to handle most common loads in the field. The optional power supply can provide power for various balance-of-system components such as string combiner monitoring, weather stations, cell routers, and other monitoring options.

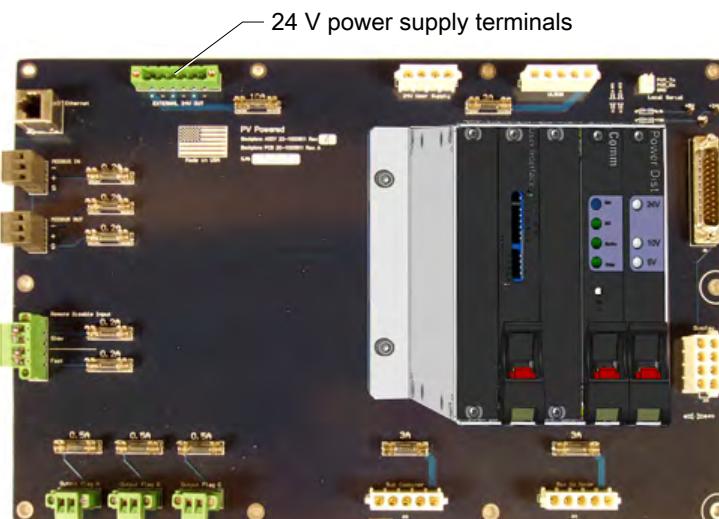
If a 24 V power supply option was not included when the inverter was ordered, the power supply will not be factory installed and the inverter's field terminals will not have power available. In an installation situation requiring additional power and the

24 V power supply is not installed, an additional power supply will need to be provided by the installer. The additional power supply will need to be installed external to the inverter.

The integrated 24 V power supply meets the following specifications:

- Output voltage: 24 VDC
- Output current: 10 A
- Output wattage: 240 W
- Fuse size: 10 A

When sizing a power supply it is recommended the load not exceed 80% of name plate capacity to prolong the life of the power supply and avoid nuisance trips caused by inrush current. For example, if the total load capacity of all the field devices powered by the 24 VDC power supply exceeds 80% of the rating, a second power supply is recommended. If a second power supply is used it must be provided by the installer and mounted external to the inverter. For this configuration, the loads must be separated and the 24 VDC supplies isolated from each other.



**Figure 4-23.** 24 V power supply terminal location

## WIRING THE 24 V POWER SUPPLY

The data monitoring compartment on the upper left side of the inverter contains the communications interface PCB. The 24 VDC terminals are located on the communications interface PCB.

### Parts or Tools Required

You need the following parts and/or tools to make the remote disable connection:

- Control voltage wire (size depends on calculated voltage drop)
- Wire stripper

- Small flat head screwdriver
- Voltage meter

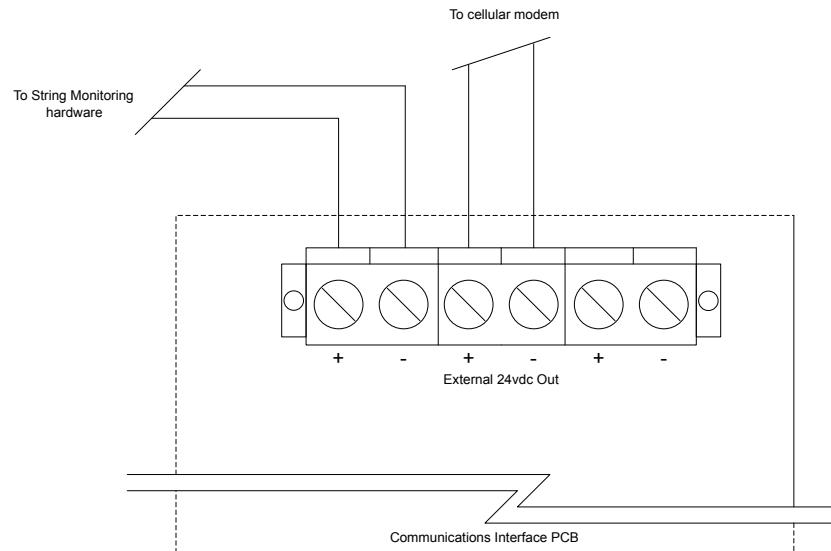
### To Make the 24 V Terminal Connections

The following information describes how to make the 24 V power supply connection on the AE 500 inverter. The 24 V terminal block contains three sets of terminals to run control power wiring to the field. These terminals are electrically connected together and pull power from the same power supply.

 **Important**

Load calculations determining the total load for the terminal block should be completed prior to wiring the terminal connections.

1. Disconnect the power to the inverter before wiring the terminal connections.
2. Remove the data monitoring compartment plate on the upper left front of the inverter.
3. Locate the 24 V power supply terminal block located on the communications interface PCB in the data monitoring compartment.



**Figure 4-24.** 24 V wiring example

4. Strip approximately 1/4" (6 mm) of insulation from each conductor coming from the 24 V power supply.
5. Insert the stripped wires in the 24 V power supply terminal block and tighten the screws.

# Operation

## SYSTEM STARTUP PROCEDURE

### **WARNING:**

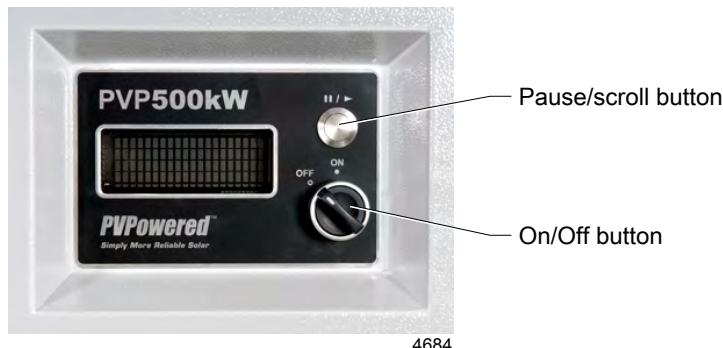
Before turning on the inverter, ensure that the front panels are closed properly.

### **AVERTISSEMENT:**

Assurez-vous de la bonne fermeture des panneaux antérieurs avant de mettre l'onduleur en route.

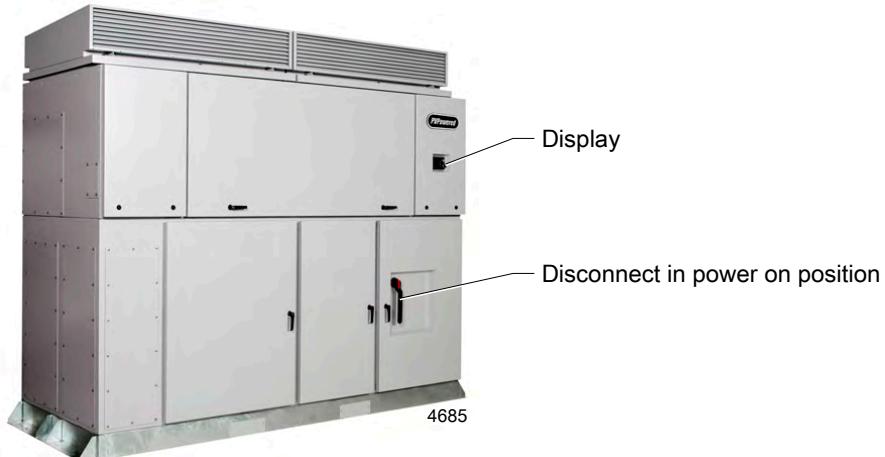
### To Start the Inverter

1. Turn the ON/OFF switch to the **OFF** position.  
The ON/OFF switch is located next to the display screen.
2. Open the door to the DC combiner sub panel.
3. Check the polarity of the DC positive and negative connectors to ensure they are wired correctly.
4. Confirm the PV panel open circuit voltage is at or below 600 VDC.
5. Turn all DC breakers to the ON position.
6. Close all upper and lower cabinet doors.
7. Turn on the external AC connection to the inverter.
8. Turn on the external DC disconnect to provide DC power to the inverter.
9. Turn the inverter's AC disconnect (if equipped) to the power ON position.



10. Turn the ON/OFF switch to the **ON** position.

After five minutes, the inverter starts to produce power into the AC grid if all necessary operating conditions are met.

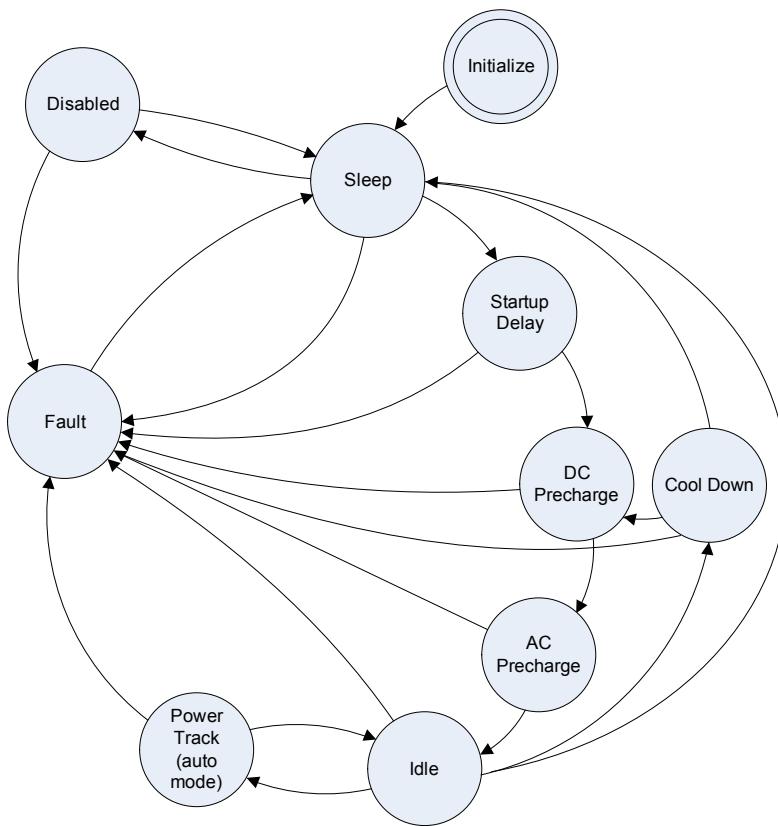


*Figure 5-1. Inverter with AC disconnect power ON*

If the unit fails to power on, use the troubleshooting information provided in this manual. If those steps do not resolve the problem, contact your service provider or AE Solar Energy Technical Support.

## INVERTER OPERATING STATES

The AE 500 inverter has ten operating states. The inverter will transition from one state to another only as shown in the following figure. Each operating state is described below.



**Figure 5-2. Inverter state diagram**

- **Initialize:** The inverter enters this state after a power cycle. Variables and devices are initialized and I/O ports set. When initialization is complete, the inverter enters the sleep state.
- **Disabled:** The inverter enters this state when the front-panel switch is in the **OFF** position or when a disable command is received over the Modbus connection. If a fault condition occurs, the inverter switches to the fault state. When the fault is cleared and the condition no longer exists, the inverter returns to the disabled state. The inverter displays a message on the screen indicating the inverter is disabled. When an enable command is received or the front-panel switch is changed to the **ON** position, the inverter switches to the sleep state. The inverter will also enter the disabled state when the remote disable input feature is applied.
- **Fault:** The inverter enters this state when any fault condition occurs. The inverter can enter this state from any other state except initialize. Unless the fault is latching, the inverter clears the fault when the fault condition subsides. The inverter displays the fault codes and messages indicating the current fault conditions. If the fault is latching, the inverter switches to the latched fault state. The inverter enters this state when a latching fault condition occurs. The inverter displays fault codes and messages indicating the current fault conditions. When the fault is cleared, the inverter switches to the sleep state. Descriptions of the inverter faults are included in the Troubleshooting chapter.

- Sleep: In this state, the inverter is enabled but the DC voltage is below the minimum operating window. When the PV input voltage rises above the starting voltage, the inverter switches to the startup delay state.
- Startup Delay: In this state, the inverter delays a specified time and then enters the DC precharge state. The delay depends on the conditions prior to the sleep state and the time taken to reach this state from the previous shutdown. If a grid interactive fault occurred on the previous shutdown, the inverter will remain in this state for five minutes.
- DC Precharge: In this state, the inverter closes the DC precharge-contactor, which limits inrush current into the DC bus capacitors. When the DC bus voltage reaches the PV input voltage and is greater than the DC start voltage, the inverter switches to the AC precharge state.
- AC Precharge: In this state, the inverter closes the main DC contactor and the AC precharge-contactor, which limits inrush current into the transformer. Once the transformer is magnetized, the main AC contactor is closed and the AC precharge contactor is opened. After a short delay the inverter switches to the idle state.
- Idle: In this state, the inverter stops energy conversion and displays a message indicating that the inverter is idle. The inverter switches to the power tracking state when the DC voltage is above the DC start voltage. If a fault condition occurs, the inverter switches to the fault state. If the DC voltage drops below the minimum, the inverter switches to the sleep state.
- Cool Down: In this state, the inverter opens the main DC contactor but leaves the main AC contactor closed to run the cooling fans. The inverter remains in this state until the inverter temperatures are below the shutdown threshold. If the PV input voltage rises above the start threshold, the inverter will transition from this state to the DC precharge state.
- Power Track: In this state, the inverter operates in voltage control mode using the maximum power point tracking (MPPT) function. If a fault occurs, the inverter switches to the fault state.

### Related Links

- “Troubleshooting and Solar Energy Technical Support” on page 8-1

## DISPLAY SCREENS AND OPERATION

The digital display located on the front of the AE inverter includes both a scrolling display screen and buttons for operating. The display provides the unit operator with information about the current state of the inverter.

There are five sets of screens that may display depending on the state of the inverter. The five sets are:

- Initialize: The initialize state is displayed on the screen when the inverter is first turned on.
- Energy tracking: These are the normal power production states of idle, run, and AC and DC precharge. Following the startup delay, the inverter goes to energy tracking which starts with the DC and AC precharge and then goes to idle and run.
- Fault
- Warning
- Disabled

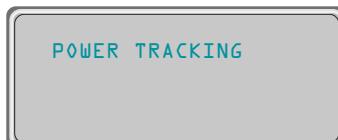
The display screens for each state are shown in the following figures. When there is a series of display screens associated with the inverter state then the inverter will continuously scroll through these screens.



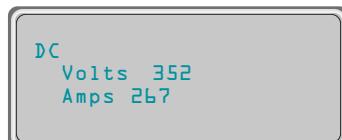
**Figure 5-3.** Initialize state screen



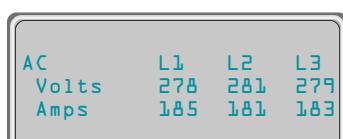
Screen 1: Product



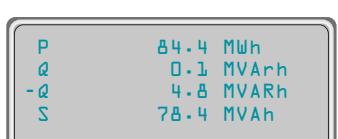
Screen 2: Power tracking



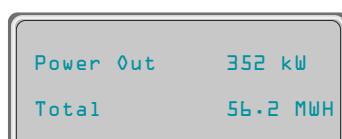
Screen 3: DC values



Screen 4: AC values



Screen 5: Power controls



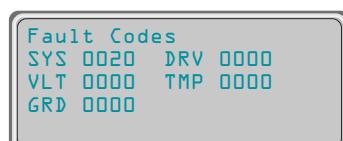
Screen 6: Power values

**Figure 5-4.** Energy tracking state screens



### Important

The DC current display is not a precise measurement.



Screen 1: Fault code(s)



Screen 2: Fault text



Screen 3: Contact information

**Figure 5-5.** Fault state screens



**Figure 5-6.** Warning state screen

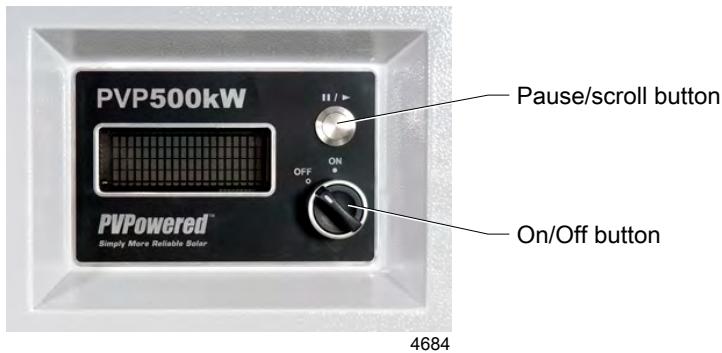


**Figure 5-7.** Disabled state screen

## To Operate the Display

The inverter display scrolls through a series of display screens based on the current state of the inverter. To operate the display:

- Press the **Pause/Scroll** button to pause the display on a specific screen
- Press the **Pause/Scroll** button again to resume the scroll function



**Figure 5-8.** Inverter display and switch



### Important

The ON/OFF switch disables the inverter, turning off inverter output power.

## GROUND FAULT INTERRUPT DEVICE

The inverter is equipped with a ground fault detector interrupter (GFDI). The purpose of the GFDI is to detect a ground fault (unintended current flow from the solar panels to earth ground) and in this event, disable the inverter.

**WARNING:**

For the GFDI circuit to function as designed, the solar array safety ground must not be connected to the PV array positive or negative leads. Bonding the safety ground to the grounded leg of the array anywhere but through the inverter will cause the GFDI circuit to be bypassed. This would defeat the operation of the GFDI and potentially create an unsafe operating condition.

**AVERTISSEMENT:**

Pour que le circuit GFDI fonctionne normalement, la prise de terre de sécurité du système PV ne doit pas être branché aux câbles positifs ou négatifs des piles PV. Brancher la prise de terre de sécurité au pied des piles ou à toute autre partie que l'onduleur causerait une mise hors circuit du GFDI. Ceci ne empêcherait le fonctionnement normale du circuit GFDI et créerait des conditions de fonctionnement potentiellement dangereuses.

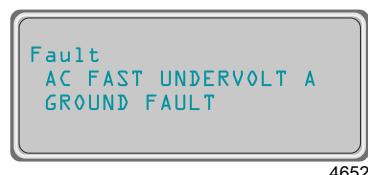
The GFDI functions using a 5 A fuse to connect or bond the solar array negative (or the solar array positive, if using a positively grounded panel array) to earth ground.

If the ground fault current exceeds 5 A between the grounded array terminal and the earth ground, the fuse will open and disconnect the solar panels from their ground reference, interrupting the ground fault. In this situation, the inverter will cease operation and display a ground fault message.

## To Respond to a Ground Fault

- If the inverter displays a ground fault as shown in the following figure turn off the AC and DC to the inverter and refer to the inverter maintenance and troubleshooting information.

The following figure shows the inverter ground fault error message.



*Figure 5-9. Ground fault error message*

## TO SHUTDOWN THE INVERTER

**DANGER:**

This unit contains energy storage devices that take up to 5 minutes to discharge. Verify the high energy capacitors are completely discharged before working on this unit.

**DANGER:**

Cette unité contient des dispositifs de stockage d'énergie qui prennent jusqu'à 5 minutes pour se décharger. Vérifier que les condensateurs à haute énergie sont complètement déchargés avant de travailler sur l'unité.

1. Turn the ON/OFF switch on the display to **OFF** position.
2. Turn the AC disconnect (if equipped) to the power OFF position by rotating the AC power lever to the position shown in the following figure.

The display on the upper front panel should be inactive.



*Figure 5-10. AC disconnect power OFF*

3. Open the utility connection circuit breaker.
4. Disconnect the PV array connection to the inverter using the external PV disconnect.

## De-energize/Isolation Procedures



### DANGER:

Risk of electrical shock. When exposed to light, PV arrays create electrical energy that could cause a hazardous condition.



### DANGER:

Risque d'électrocution. L'autorisation officielle de votre compagnie locale d'électricité est requise avant de brancher l'onduleur sur le réseau public. Seul le personnel qualifié est autorisé à brancher le dispositif sur le réseau public d'électricité.



### DANGER:

This unit contains energy storage devices that take up to 5 minutes to discharge. Verify the high energy capacitors are completely discharged before working on this unit.



### DANGER:

Cette unité contient des dispositifs de stockage d'énergie qui prennent jusqu'à 5 minutes pour se décharger. Vérifier que les condensateurs à haute énergie sont complètement déchargés avant de travailler sur l'unité.

The following procedure should be followed to de-energize the inverter for maintenance.

### TO DE-ENERGIZE THE INVERTER

1. Turn the inverter's ON/OFF switch to the **OFF** position.
2. Disconnect the PV array connection to the inverter using the external PV disconnect
3. Turn the AC disconnect (if equipped) to the power OFF position by rotating the AC power lever to the off position.  
The display on the upper front panel should be inactive.
4. Open the utility connection circuit breaker or the overcurrent protection device, a breaker or disconnect.
5. Install LOTO devices on the equipment as necessary to comply with LOTO requirements.

## Inverter Enable/Disable Controls

The table below shows the interaction of the inverter on/off controls. Cells containing an *x* can be in either state.

*Table 5-1. Inverter enable/disable*

Inverter Enable/ Disable Switch	Inverter Disconnect Switches	Remote Enable/ Disable	Modbus Enable/Disable	Inverter Status
<b>On</b>	Closed	Enabled	Enabled	Enabled
<b>Off</b>	<i>x</i>	<i>x</i>	<i>x</i>	Disabled
<i>x</i>	Open	<i>x</i>	<i>x</i>	Disabled
<i>x</i>	<i>x</i>	Disabled	<i>x</i>	Disabled
<i>x</i>	<i>x</i>	<i>x</i>	Disabled	Disabled

# Data Monitoring and Controls

## NETWORKING AND PERFORMANCE MONITORING

The inverter has an integrated data monitoring module located in the dedicated data monitoring compartment. The data monitoring module enables access to the inverter performance data using the following methods:

- Basic performance data can be accessed using a free web-based monitoring service provided by AE.
- The data monitoring module can deliver data to a third party monitoring system through a Modbus/TCP over an Ethernet network, or Modbus/RTU over an RS-485 network.

### Ethernet Network Connection

An Ethernet connection can be used to connect the unit to the internet, or to a local Modbus/TCP network not connected to the internet. AE offers a free basic monitoring service through the [solarenergy.advanced-energy.com](http://solarenergy.advanced-energy.com) website. Internet service must be set up at the installation site before the inverter can be accessed online. The data monitoring module supports only hard-wired CAT5 solutions to the inverter. The module does NOT support wireless configurations. To access the data monitoring information, customers need to provide a broadband Ethernet connection to the inverter, based on the following specifications:

- Provide a DHCP-enabled, or static IP based broadband internet connection that is always ON. This can be cable internet, a DSL line, or equivalent.
- Provide a hard-wired, Ethernet connection between the communications interface PCB in the inverter and the closest site LAN connection.
  - If multiple inverters are commissioned to a single site, an Ethernet hub can be located in an outdoor-rated enclosure to distribute the LAN to the inverters.



#### Important

The data monitoring module does not support dial-up modem connectivity.



#### Important

Some complex networks may require a system administrator to add the inverter to the network, or to configure the unit to a static IP address.

All AE commercial inverters come standard with an Ethernet port that is intended to be connected to the Internet or to a local area network for Modbus/TCP. The commercial inverter operates as an Internet appliance. The inverter communicates

with the AE data center using https (port 443). Communications is one way – the inverter only communicates externally to the AE data center. Typically the inverter posts approximately 50 kB of data to the data center every 15 minutes. The inverter may post data more frequently for a short period of time if there is an inverter fault.

## Connecting the Ethernet Cable

### PARTS OR TOOLS REQUIRED

You need the following parts and/or tools to make the Ethernet cable connection:

- Ethernet LAN cable (Category 5 or above)
- RJ45 modular connector plugs
- Appropriate conduit fitting
- Ethernet hub, switch or router to provide network connectivity
- Cable tester

### TO MAKE THE INVERTER'S ETHERNET CONNECTION

Use the following steps to complete the connection of the Ethernet cable to the inverter's communication interface PCB:

1. Route the Ethernet (CAT5) cable from the Internet-enabled router, at the gland plate location on the upper left side of the inverter, using the proper conduit and hub connectors.



#### Important

The Ethernet cable must comply with T-568B standards as shown in the following figure. This is the only configuration supported by the data monitoring module. Other wiring configurations will not work.

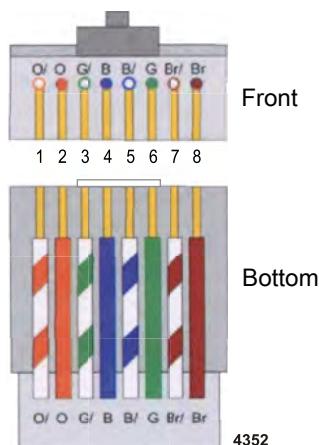
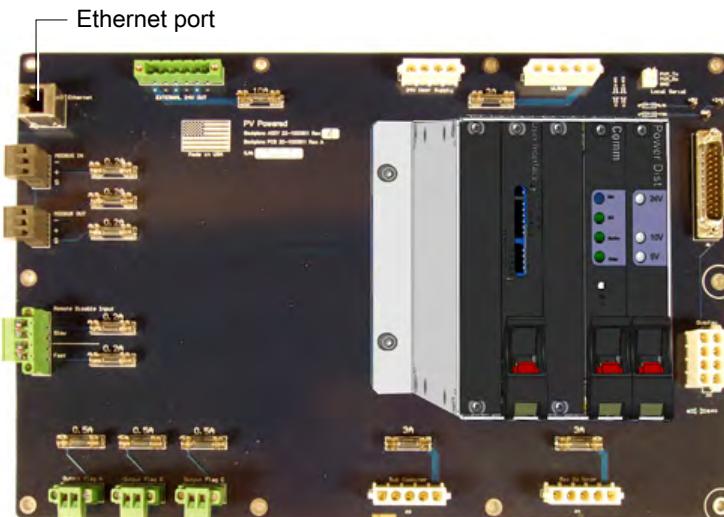


Figure 6-1. T-568B compliant Ethernet cable

2. Plug the Ethernet cable into the Ethernet port on the communication interface PCB located in the data monitoring section of the inverter. Refer to the following figure for the port location.



**Figure 6-2. Communication interface PCB Ethernet port location**

#### Related Links

- “Conduit Entry Points” on page 4-12

## To Establish an Internet Connection with the Inverter

Below is a list of requirements to establish inverter communications with the AE data center. Connectivity must be established before registration on the site is attempted.

1. Connect the inverter's Ethernet port to a hub or router using an Ethernet cable.

Ethernet cables must meet the T-568B wiring standard and must be less than 320 feet in length. If a longer cable is needed additional networking hardware may be required.

2. Provide DHCP server access to the inverter and provide a path to the Internet for https (port 443) from the inverter.

As shipped, the inverter requires DHCP to establish its IP address. Contact AE Solar Energy Technical Support if a fixed IP address is required for your network.

3. Locate the inverter's MAC address on the label on the communications interface PCB.

The communications interface PCB must be removed from the card cage assembly to see the MAC address.

When the Internet connection is established, go to the AE web site and navigate to the PVP Commercial Monitoring page to register the inverter and begin using the

monitoring tools. Contact AE Solar Energy Technical Support if additional information is needed on how to use the online tool.

## To Verify Data Monitoring Connectivity

Verify connectivity using the following information:

1. Check the status light located on the front of the communication PCB in the card cage on the right side of the upper compartment in the data monitoring section.  
If the green status light is in a solid on state, the data monitoring connection is established. If the status light is not solid, troubleshoot the connection.
2. Register the inverter at the AE Solar Energy web site to complete the setup for monitoring the inverter.

### Related Links

- “Troubleshooting and Solar Energy Technical Support” on page 8-1

## MODBUS OVERVIEW

The AE 500 inverter can communicate via Modbus/TCP or Modbus/RTU. This chapter is written for PV installers, electricians, controls contractors, and Modbus network programmers.

### Modbus Communication Protocol

Modbus is a serial communications protocol and is the most commonly used means of monitoring and communicating between devices in the PV industry. The Modbus protocol allows for communication between a Modbus master device and multiple Modbus slave devices connected to the same network. The physical layer for Modbus/TCP is a CAT5 Ethernet network. Modbus/RTU uses a twisted pair shielded conductor RS-485 network.

## NETWORKING USING THE MODBUS OPTION

The following steps are required to set up a Modbus TCP network for your AE inverter:

- Field installation : This step can be completed onsite by a PV installer or an electrician that does not have working knowledge of a Modbus network

- Consult the facility IT administrator for network device installation support and coordination
- Install the Modbus network communications cabling
- Modbus network configuration: This step can be done onsite or remotely and should be completed by the Modbus network programmer
  - Set the IP address assigned to the inverter and port 502 for Modbus TCP
  - Configure the point maps for the slave devices

## Modbus TCP Installation

Disconnect the power to the inverter before starting the installation.



### DANGER:

Risk of electrical shock. High voltages are present in the inverter cabinet. Both AC and DC disconnects must be in the OFF position when working on the unit. Wait five minutes to discharge high voltage before opening the front panels of the inverter.



### DANGER:

Risque d'électrocution. L'intérieur de l'onduleur est soumis à des hautes tensions. Les interrupteurs de courant alternatif et continu doivent être mis HORS TENSION durant les travaux sur l'unité. Attendez cinq minutes afin de permettre la décharge du courant haute tension avant de démonter les panneaux avant de l'onduleur.

## TO INSTALL THE MODBUS TCP CABLE

1. Remove the data monitoring gland plate on the left side of the inverter.  
The data monitoring gland plate is a flat piece of metal covering the side entry port to the inverter's data monitoring compartment.
2. Cut a hole in the desired location to allow access for the cable.
3. Install a water-tight conduit hub connection.
4. Replace the gland plate.
5. Route an Ethernet cable from a network port in the facility that has been approved by the network administrator through the conduit hub.
6. Connect the Ethernet cable to the Ethernet port on the communication interface PCB.

The communication interface PCB is located in the data monitoring section in the left upper compartment of the inverter.



*Figure 6-3. Communication interface PCB in the data monitoring section*

## Modbus TCP Network Configuration

### TO ASSIGN THE IP ADDRESS AND PORT ID

1. Contact the facility's IT Network Administrator (or person with similar responsibilities) to assign an IP address to each inverter. Advanced users can assign a static IP address.  
Contact AE Solar Energy Technical Support for assistance.
2. Set the Modbus master to communicate through port 502.

## NETWORKING USING THE MODBUS RS-485 OPTION

The following steps are required to set up a Modbus RS-485 network for the AE inverter:

- Field installation : This step can be completed onsite by a PV installer or an electrician that does not have working knowledge of a Modbus network
  - Installing the Modbus network wiring
  - Configuring end-of-line termination and network biasing
  - Setting the Modbus address for each slave inverter

**Important**

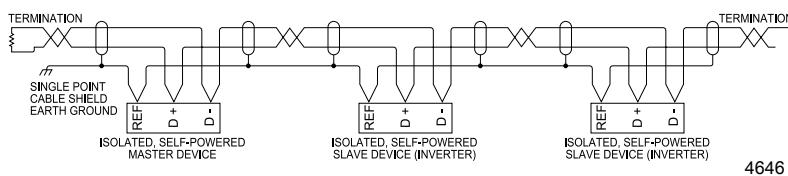
The contractor responsible for network programming will need to provide the slave addresses prior to setting the Modbus address for each slave inverter.

The final part of the RS-485 installation process is the Modbus network configuration. These steps should be completed by the Modbus network programmer. The last two steps are:

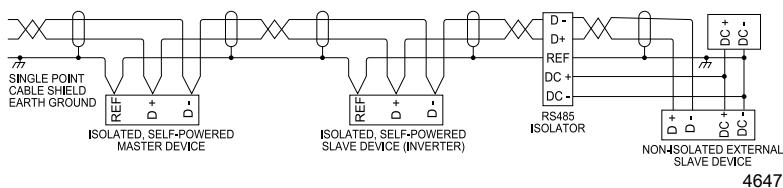
- Setting the device addresses so the Modbus master program will accept the Modbus addresses assigned during the field installation
- Configuring point maps for slave devices

## Network Layout

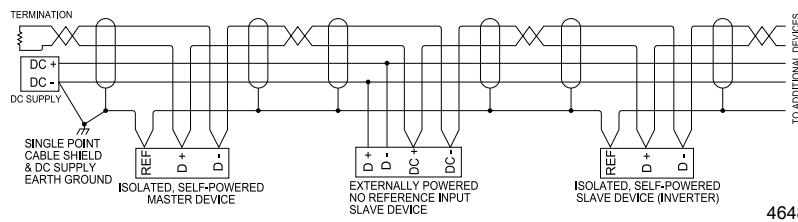
When multiple inverters or other Modbus slave devices are connected to a single Modbus master device, the multiple devices need to be connected in one of the three daisy chain layouts shown in the following figure.



**Figure 6-4.** Daisy chain layout for RS-485 network: option A



**Figure 6-5.** Daisy chain layout for RS-485 network: option B



**Figure 6-6.** Daisy chain layout for RS-485 network: option C

**Important**

When multiple devices are wired to the network, the network shield must be terminated to earth ground at one point on the network, typically at the beginning or the end. For device connections the shield must be rewired to provide a continuous shield and isolated from ground.

## Installing the Modbus RS-485 Cable

### MODBUS RS-485 WIRING REQUIREMENTS

The Modbus RTU connections are made using shielded, insulated, 18-24 gauge twisted-pair communication cable that has a characteristic impedance of 120 ohms. If the RS-485 network will not pass through any high voltage (> 300 V) areas, then 300 V rated cable may be used in the low voltage data monitoring compartment of the inverter. Check with your local inspector or project engineer if you need assistance in determining this requirement. Some appropriate 300 V data cables include:

- Belden 3105A (1P22AWG shielded)
- Belden 3082A (1P15AWG + 1P18AWG shielded)

Belden 7897A (1P15AWG + 1P18AWG shielded) is an example of a 600 V rated cable that may also be used; others exist as well.

### TO INSTALL THE MODBUS RS-485 CABLE



#### DANGER:

Risk of electrical shock. High voltages are present in the inverter cabinet. Both AC and DC disconnects must be in the OFF position when working on the unit. Wait five minutes to discharge high voltage before opening the front panels of the inverter.



#### DANGER:

Risque d'électrocution. L'intérieur de l'onduleur est soumis à des hautes tensions. Les interrupteurs de courant alternatif et continu doivent être mis HORS TENSION durant les travaux sur l'unité. Attendez cinq minutes afin de permettre la décharge du courant haute tension avant de démonter les panneaux avant de l'onduleur.

1. Disconnect the power to the inverter before starting the installation.
2. Remove the data monitoring gland plate on the upper left side of the inverter.  
The data monitoring gland plate is a flat piece of metal covering the side entry port to the inverter's data monitoring compartment.
3. Punch or drill a hole in the desired location to allow access for the cable.
4. Install a water-tight conduit hub connection.
5. Replace the gland plate.
6. Route a RS-485 cable from the master device on the Modbus network port in the facility that has been approved by the network administrator through the conduit hub.

7. Connect each Modbus cable to a slave port terminal block on the communications interface PCB. Connect the plus (+) cables to plus (+) connections and the minus (-) cables to minus (-) connections so they correspond throughout the network.

*Note:* Two slave port terminal blocks, wired in parallel, are available to simplify wiring in a daisy-chain network.



**Figure 6-7.** Communications interface PCB with Modbus slave port location

8. Connect a ground reference line to the terminal labeled S on the Modbus slave terminal block.

The shield of a communications cable may be used for this reference as long as the shield is connected to earth ground at one point only. AE recommends that all AE inverters have connected grounds when possible.



#### Important

Some Modbus devices do not have a shield or reference input. In these cases the device most often uses the DC power supply (-) as the RS-485 reference. It may be necessary to place an RS-485 isolator on these devices or power them from a common DC supply that has its DC (-) referenced to earth ground at the same point where the network cable shield is earthed.

## Setting the DIP Switches

By default, the termination uses three switches that are set in the disabled position when the inverter is shipped. The location of the switches can determine the following settings for an inverter:

- Terminate the network
- Determine the center inverter(s) on the network
- Turn on biasing



**Figure 6-8.** Termination switches on the user interface PCB

The performance of your Modbus network may require each end of the network to be terminated using  $120\ \Omega$  termination resistors. When the network is long, relative to the RS-485 bit rate in use, bus terminations must be installed. The network length is determined by the total backbone cable length and not necessarily the line-of-sight between the two furthest apart devices.

**Table 6-1. Maximum network length per Modbus bit rate**

RS-485/Modbus Bit Rate	Maximum Network Length Without Termination in Feet (Meters)	Maximum Network Length With Termination in Feet (Meters)
9600 bps	1000 (305)	4000 (1200)
19,200 bps	500 (152)	4000 (1200)
38,400 bps	250 (76)	4000 (1200)
57,600 bps	150 (46)	4000 (1200)

## TO TERMINATE THE INVERTER NETWORK

If bus termination is desired and the inverter is on the end of the Modbus network, you need to set the termination.

On the front of the user interface PCB, using the **Modbus Termination** switches:

- Place the **Line** switch in the **On** position.

## TO SET THE CENTER INVERTERS FOR THE NETWORK

On the front of the user interface PCB, using the **Modbus Termination** switches:

1. Place the **Low** switch in the **OFF** position.
2. Place the **Line** switch in the **OFF** position.
3. Place the **High** switch in the **OFF** position.

## TO SET NETWORK BIASING

Biasing sets the voltage levels on the data lines of an inactive or idle network. At least one device on the network must provide biasing. On shorter networks with fewer installed devices, biasing may only be needed on the device furthest away from the master. Longer networks that are terminated on both ends may require two devices to have their biasing enabled.

### To Set the Jumpers to Use the Inverter's Built-in Biasing

On the front of the user interface PCB, using the **Modbus Termination** switches:

1. Place the **Low** switch in the **ON** position.
2. Place the **Line** switch in the **OFF** position.
3. Place the **High** switch in the **ON** position.

## TO TERMINATE THE NETWORK AND ENABLE BIASING

As an alternative, an end inverter on the network can require both termination and biasing to be enabled. On the front of the user interface PCB, set the following switches to configure the inverter for both settings.

1. Place the **Low** switch in the **ON** position.
2. Place the **Line** switch in the **ON** position.
3. Place the **High** switch in the **ON** position.

## Setting the Modbus Address

A Modbus network containing slave devices requires a unique address for each slave. These unique addresses allow the master device to identify and communicate with each slave. The Modbus network administrator must assign a unique Modbus address to each AE inverter.

The **Modbus Address** switches are located on the user interface PCB in the card cage in the data monitoring compartment.



*Figure 6-9. Setting the Modbus address*

## TO SET THE MODBUS ADDRESS

1. Determine each slave address.
2. Set the address on each slave device.

The slave address is set using the **Modbus Address** switches on the front of the user interface PCB.

 **Important**

0 is not an allowed address.

 **Important**

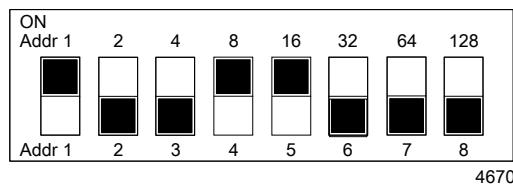
Some Modbus master devices do not allow addresses above the decimal value of 126. AE recommends keeping the number of slave devices between 2 and 100.

### Device Addressing Example

Each inverter must be set to a unique address specified by the site monitoring contractor. The address is set using a binary code on the address DIP switch.

To set an inverter to an address of 25:

1. Find the desired address in the left hand column of the table below labeled “Unit Address”.
2. Identify which switches, by switch number, must be set to the **ON** position.  
For example, an address of 25 requires switch numbers **1**, **4**, and **5** to **ON**.
3. Once the switches are set in the **ON** position, the switch should look like the figure below.



**Figure 6-10.** Example: Unit address switch set to address 25

If you need more device addresses than the 80 provided in the following table, refer to a complete digital to binary conversion table.

**Table 6-2.** Inverter address table

Unit Address (decimal)	Switch Number							
	1	2	3	4	5	6	7	8
	Switch Address							
	1	2	4	8	16	32	64	128
1	ON	Off						
2	Off	ON	Off	Off	Off	Off	Off	Off
3	ON	ON	Off	Off	Off	Off	Off	Off
4	Off	Off	ON	Off	Off	Off	Off	Off
5	ON	Off	ON	Off	Off	Off	Off	Off
6	Off	ON	ON	Off	Off	Off	Off	Off
7	ON	ON	ON	Off	Off	Off	Off	Off
8	Off	Off	Off	ON	Off	Off	Off	Off
9	ON	Off	Off	ON	Off	Off	Off	Off
10	Off	ON	Off	ON	Off	Off	Off	Off
11	ON	ON	Off	ON	Off	Off	Off	Off
12	Off	Off	ON	ON	Off	Off	Off	Off
13	ON	Off	ON	ON	Off	Off	Off	Off
14	Off	ON	ON	ON	Off	Off	Off	Off
15	ON	ON	ON	ON	Off	Off	Off	Off
16	Off	Off	Off	Off	ON	Off	Off	Off
17	ON	Off	Off	Off	ON	Off	Off	Off
18	Off	ON	Off	Off	ON	Off	Off	Off
19	ON	ON	Off	Off	ON	Off	Off	Off
20	Off	Off	ON	Off	ON	Off	Off	Off
21	ON	Off	ON	Off	ON	Off	Off	Off
22	Off	ON	ON	Off	ON	Off	Off	Off

Table 6-2. Inverter address table (Continued)

Unit Address (decimal)	Switch Number							
	1	2	3	4	5	6	7	8
	Switch Address							
	1	2	4	8	16	32	64	128
23	ON	ON	ON	Off	ON	Off	Off	Off
24	Off	Off	Off	ON	ON	Off	Off	Off
25	ON	Off	Off	ON	ON	Off	Off	Off
26	Off	ON	Off	ON	ON	Off	Off	Off
27	ON	ON	Off	ON	ON	Off	Off	Off
28	Off	Off	ON	ON	ON	Off	Off	Off
29	ON	Off	ON	ON	ON	Off	Off	Off
30	Off	ON	ON	ON	ON	Off	Off	Off
31	ON	ON	ON	ON	ON	Off	Off	Off
32	Off	Off	Off	Off	Off	ON	Off	Off
33	ON	Off	Off	Off	Off	ON	Off	Off
34	Off	ON	Off	Off	Off	ON	Off	Off
35	ON	ON	Off	Off	Off	ON	Off	Off
36	Off	Off	ON	Off	Off	ON	Off	Off
37	ON	Off	ON	Off	Off	ON	Off	Off
38	Off	ON	ON	Off	Off	ON	Off	Off
39	ON	ON	ON	Off	Off	ON	Off	Off
40	Off	Off	Off	ON	Off	ON	Off	Off
41	ON	Off	Off	ON	Off	ON	Off	Off
42	Off	ON	Off	ON	Off	ON	Off	Off
43	ON	ON	Off	ON	Off	ON	Off	Off
44	Off	Off	ON	ON	Off	ON	Off	Off
45	ON	Off	ON	ON	Off	ON	Off	Off
46	Off	ON	ON	ON	Off	ON	Off	Off
47	ON	ON	ON	ON	Off	ON	Off	Off
48	Off	Off	Off	Off	ON	ON	Off	Off
49	ON	Off	Off	Off	ON	ON	Off	Off
50	Off	ON	Off	Off	ON	ON	Off	Off
51	ON	ON	Off	Off	ON	ON	Off	Off
52	Off	Off	ON	Off	ON	ON	Off	Off

*Table 6-2. Inverter address table (Continued)*

Unit Address (decimal)	Switch Number							
	1	2	3	4	5	6	7	8
	Switch Address							
	1	2	4	8	16	32	64	128
53	<b>ON</b>	Off	<b>ON</b>	Off	<b>ON</b>	<b>ON</b>	Off	Off
54	Off	<b>ON</b>	<b>ON</b>	Off	<b>ON</b>	<b>ON</b>	Off	Off
55	<b>ON</b>	<b>ON</b>	<b>ON</b>	Off	<b>ON</b>	<b>ON</b>	Off	Off
56	Off	Off	Off	<b>ON</b>	<b>ON</b>	<b>ON</b>	Off	Off
57	<b>ON</b>	Off	Off	<b>ON</b>	<b>ON</b>	<b>ON</b>	Off	Off
58	Off	<b>ON</b>	Off	<b>ON</b>	<b>ON</b>	<b>ON</b>	Off	Off
59	<b>ON</b>	<b>ON</b>	Off	<b>ON</b>	<b>ON</b>	<b>ON</b>	Off	Off
60	Off	Off	<b>ON</b>	<b>ON</b>	<b>ON</b>	<b>ON</b>	Off	Off
61	<b>ON</b>	Off	<b>ON</b>	<b>ON</b>	<b>ON</b>	<b>ON</b>	Off	Off
62	Off	<b>ON</b>	<b>ON</b>	<b>ON</b>	<b>ON</b>	<b>ON</b>	Off	Off
63	<b>ON</b>	<b>ON</b>	<b>ON</b>	<b>ON</b>	<b>ON</b>	<b>ON</b>	Off	Off
64	Off	Off	Off	Off	Off	Off	<b>ON</b>	Off
65	<b>ON</b>	Off	Off	Off	Off	Off	<b>ON</b>	Off
66	Off	<b>ON</b>	Off	Off	Off	Off	<b>ON</b>	Off
67	<b>ON</b>	<b>ON</b>	Off	Off	Off	Off	<b>ON</b>	Off
78	Off	Off	<b>ON</b>	Off	Off	Off	<b>ON</b>	Off
69	<b>ON</b>	Off	<b>ON</b>	Off	Off	Off	<b>ON</b>	Off
70	Off	<b>ON</b>	<b>ON</b>	Off	Off	Off	<b>ON</b>	Off
71	<b>ON</b>	<b>ON</b>	<b>ON</b>	Off	Off	Off	<b>ON</b>	Off
72	Off	Off	Off	<b>ON</b>	Off	Off	<b>ON</b>	Off
73	<b>ON</b>	Off	Off	<b>ON</b>	Off	Off	<b>ON</b>	Off
74	Off	<b>ON</b>	Off	<b>ON</b>	Off	Off	<b>ON</b>	Off
75	<b>ON</b>	<b>ON</b>	Off	<b>ON</b>	Off	Off	<b>ON</b>	Off
76	Off	Off	<b>ON</b>	<b>ON</b>	Off	Off	<b>ON</b>	Off
77	<b>ON</b>	Off	<b>ON</b>	<b>ON</b>	Off	Off	<b>ON</b>	Off
78	Off	<b>ON</b>	<b>ON</b>	<b>ON</b>	Off	Off	<b>ON</b>	Off
79	<b>ON</b>	<b>ON</b>	<b>ON</b>	<b>ON</b>	Off	Off	<b>ON</b>	Off
80	Off	Off	Off	Off	<b>ON</b>	Off	<b>ON</b>	Off

# MODBUS COMMANDS

All AE commercial inverters support basic Modbus commands. The commands in the following table are used to read and write (set) inverter operating parameters or obtain the unit's identifying information.

**Table 6-3.** Modbus commands

Command Name	Command Number	Description
<b>Read Holding Register</b>	03	Read value from the register
<b>Write (preset) Single Register</b>	06	Write value to the register
<b>Return Slave ID</b>	17	Returns a text string containing the ID number of the inverter.  The format of the ID returned is dependent on the version of the inverter. <ul style="list-style-type: none"> <li>"PVP Inverter IDxxxxxxxxxxxx" on older models</li> <li>"xxPVP Inverter IDxxxxxxxxxxxx" for newer models</li> </ul>

## Modbus Command Format

The **Read Holding Register** command is used to read values from Modbus registers.

**Table 6-4.** Format for Read Holding Register command

Command Information	Command Layout
Modbus address	nn
Command number	03
First register MSB	xx
First register LSB	xx
Data MSB	xx
Data LSB	xx
CRC LSB	xx

**Table 6-4.** Format for Read Holding Register command (Continued)

Command Information	Command Layout
CRC MSB	xx

**Table 6-5.** Response format for Read Holding Register command

Response Information	Response Layout
Modbus address	nn
Command number	03
Number of bytes of data	n
First register MSB	xx
First register LSB	xx
Second register MSB	xx
Second register LSB	xx
Nth register MSB	xx
Nth register LSB	xx
CRC LSB	xx
CRC MSB	xx

The **Write Single Register** command is used to write data to a register.

**Table 6-6.** Format for Write Single Register command

Command Information	Command Layout
Modbus address	nn
Command number	06
First register MSB	xx
First register LSB	xx
Data MSB	xx
Data LSB	xx
CRC LSB	xx
CRC MSB	xx

**Table 6-7.** Response format for Write Single Register command

Response Information	Response Layout
Modbus address	nn
Command number	06

**Table 6-7.** Response format for Write Single Register command (Continued)

Response Information	Response Layout
Number of bytes of data	n
First register MSB	xx
First register LSB	xx
Data MSB	xx
Data LSB	xx
CRC LSB	xx
CRC MSB	xx

## Return Slave ID

The **Return Slave ID** command is used to read a text string containing the ID number of the inverter.

**Table 6-8.** Format for Return Slave ID

Command Information	Command Layout
Modbus slave address	nn (1-126)
Command number	11h

The **Return Slave ID** command returns the ASCII string "xxPVP Inverter IDxxxxx". for example "0x50,0xFF,PVP Inverter ID02860910080321". The first "xx" represents two non-ASCII bytes, representing the following information:

- Byte 1:0x50 - An identifier byte for the AE inverter
- Byte 2:0x00 - If communication with the inverter is down  
0xFF - If communication with the inverter is okay
- Byte 3 through byte n: Contains "PVP Inverter IDxxxxx"

**Table 6-9.** Format for Return Slave ID command

Response Information	Response Layout
Modbus slave address	11h
Command number	n
Number of bytes of data	xx
Data 1	xx
Data 2	xx
Data n	xx

**Table 6-9.** Format for Return Slave ID command (Continued)

Response Information	Response Layout
CRC LSB	xx
CRC MSB	xx

## MODBUS DATA TYPES

Modbus data types used with the AE 500 unit are shown in the following table.

**Table 6-10.** Data types

Data Type	Description
ASCII	Two ASCII characters per register For a text string the left-most character is the lowest register number.
UINT16	Unsigned integer, 16 bits Range: 0 to 65,536
SINT16	Signed integer, 16 bits Range: -32,767 to +32,767
UINT 32 (requires two registers)	Unsigned integer, 32 bits Range: 0 to 4,294,967,295
SINT32 (requires two registers)	Signed integer, 32 bits Range: -2,147,483,647 to +2,147,483,647
FLOAT (requires two registers)	IEEE 754 standard 32-bit floating point number High order 16 bits in the first of the two registers. Low order 16 bits in the second register. (Big Endian)

## MODBUS REGISTER MAPPING

The following tables list the Modbus registers with their location and a description of the data stored in the register.

### Modbus Fixed Information Registers

**Table 6-11. Modbus fixed information registers**

Description	Start Register	End Register	No. of Registers	Modbus Address	Data Type	Notes
<b>Modbus base address = 0</b>						
Inverter ID number	0	7	8	40001	ASCII	The ID number is a 16-character number that is unique for each inverter.
Inverter model number	1	2	2	40002	ASCII	The model number is extracted from four digits of the inverter ID number. <a href="#">Table 6-12</a>
Firmware version	8	11	4	40009	ASCII	This register can contain up to 8 characters. Example: V1.9
Map version	13	13	1	40014	UINT16	The range is 1 through 4. This number increments sequentially as the map changes. All versions are backwards compatible.
Inverter configuration	14	14	1	40015	UINT16	See <a href="#">Table 6-13</a> on page 6-21.
Inverter serial number	15	24	10	40016	ASCII	This register contains the serial number of the inverter (which is also on the product label). Up to 20 characters are available.
Rated power	25	25	1	40026	UINT16	kW

**Table 6-12.** Inverter model number

Inverter Model	Modbus Model Number
PVP30kW	0272, 0273, 0274, 0288, 0289, 0290
PVP35kW	0300, 0301, 0302, 0303
PVP50kW	0304, 0305, 0306, 0307
PVP75kW	0276, 0277, 0278, 0279
PVP100kW	0280, 0281, 0282, 0283
PVP250kW	0312, 0313, 0314, 0315, 0316, 0317, 0318, 0319
PVP260kW	0312, 0313, 0314, 0315, 0316, 0317, 0318, 0319
PVP500kW	0386, 0387

**Table 6-13.** Bit mapping for inverter configuration register

Inverter Configuration	Bit Mapping	Instructions
AC volts = 208	0x0001	
AC volts = 240	0x0002	
AC volts = 480	0x0004	
AC volts = 600	0x0200	
Transformer tap position	0x0008	<p>This bit is:</p> <ul style="list-style-type: none"> <li>Set if the tap is at 265 V</li> <li>Clear if the tap is 295 V</li> </ul> <p>The default is 295 V.</p>
Transformer wiring configuration	0x0010	<p>This bit is:</p> <ul style="list-style-type: none"> <li>Set if the inverter is wired as delta</li> <li>Clear if the inverter is wired as wye</li> </ul> <p>The default is wye.</p>
Utility meter installation flag	0x0100	<p>This bit is:</p> <ul style="list-style-type: none"> <li>Set if the meter is installed</li> <li>Clear if the meter is not installed</li> </ul> <p>The default is not installed.</p>

**Table 6-13.** Bit mapping for inverter configuration register (Continued)

Inverter Configuration	Bit Mapping	Instructions
Positive ground	0x0400	<p>This bit is:</p> <ul style="list-style-type: none"> <li>• Set if the inverter is configured for positive ground</li> <li>• Clear if the inverter is configured for negative ground</li> </ul> <p>Factory configured</p>
AC disconnect	0x0800	<p>This bit is:</p> <ul style="list-style-type: none"> <li>• Set if an AC disconnect is installed</li> <li>• Clear if an AC disconnect is not installed</li> </ul> <p>Factory configured</p>

## Modbus Data Registers

**Table 6-14.** Modbus data registers

Description	Start Register	End Register	No. of Registers	Modbus Address	Data Type	Notes
<b>Modbus base address = 1000</b>						
VoltsA L-N	1000	1001	2	41001	FLOAT	± 32 bit IEEE 754
VoltsB L-N	1002	1003	2	41003	FLOAT	± 32 bit IEEE 754
VoltsC L-N	1004	1005	2	41005	FLOAT	± 32 bit IEEE 754
Current A	1006	1007	2	41007	FLOAT	± 32 bit IEEE 754
Current B	1008	1009	2	41009	FLOAT	± 32 bit IEEE 754
Current C	1010	1011	2	41011	FLOAT	± 32 bit IEEE 754
DC input voltage	1012	1013	2	41013	FLOAT	± 32 bit IEEE 754
DC input current (see note)	1014	1015	2	41015	FLOAT	± 32 bit IEEE 754
Line frequency	1016	1017	2	41017	FLOAT	± 32 bit IEEE 754
Line kW	1018	1019	2	41019	FLOAT	± 32 bit IEEE 754

**Table 6-14. Modbus data registers (Continued)**

Description	Start Register	End Register	No. of Registers	Modbus Address	Data Type	Notes
<b>Modbus base address = 1000</b>						
Total kWh delivered	1020	1021	2	41021	UINT32	0 to 4.29e9
PV input voltage	1022	1023	2	41023	FLOAT	± 32 bit IEEE 754
DC kW (calculated)	1024	1025	2	41025	FLOAT	± 32 bit IEEE 754
Time since epoch	1026	1027	2	41027	FLOAT	Seconds since 01/01/1970
Total kWh	1028	1029	2	41029	UINT32	± 32 bit IEEE 754

## Modbus Status and Fault Code Registers

The following table provides information about the registers that are used to report status and fault codes. Each of these registers provides information about a group of status codes or faults. For more information on the specific faults that can be reported for each of the fault registers, see the troubleshooting information for the inverter. For more information about the status codes, see [Table 6-16](#) on page 6-24 and [Table 6-17](#) on page 6-25.

**Table 6-15. Modbus status and fault code registers**

Description	Start Register	End Register	No. of Registers	Modbus Address	Data Type	Notes
<b>Modbus base address = 2000</b>						
Inverter operating status (state)	2100	2100	1	42101	UINT16	See <a href="#">Table 6-16</a> on page 6-24.
Main fault	2101	2101	1	42102	UINT16	See the fault codes descriptions in the inverter troubleshooting information.
Drive fault	2102	2102	1	42103	UINT16	See the fault codes descriptions in the inverter troubleshooting information.

**Table 6-15. Modbus status and fault code registers (Continued)**

Description	Start Register	End Register	No. of Registers	Modbus Address	Data Type	Notes
<b>Modbus base address = 2000</b>						
Voltage fault	2103	2103	1	42104	UINT16	See the fault codes descriptions in the inverter troubleshooting information.
Grid fault	2104	2104	1	42105	UINT16	See the fault codes descriptions in the inverter troubleshooting information.
Temperature fault	2105	2105	1	42106	UINT16	See the fault codes descriptions in the inverter troubleshooting information.
System fault	2106	2106	1	42107	UINT16	See the fault codes descriptions in the inverter troubleshooting information.
System warnings	2107	2107	1	42108	UINT16	See the fault codes descriptions in the inverter troubleshooting information.
PVM (PV Monitoring) status codes	2108	2108	1	42109	UINT16	See <a href="#">Table 6-17</a> on page 6-25.

The following table contains the bitmap information for the inverter operating status register. The response values for this command are shown in the table as both hex and decimal values.

**Table 6-16. Modbus inverter operating status register values**

Description	Hex Value	Decimal Value
<b>Modbus register number = 42101</b>		
Sleep state	0	0
Startup delay state	1	1
AC precharge state	2	2

**Table 6-16.** Modbus inverter operating status register values (Continued)

Description	Hex Value	Decimal Value
<b>Modbus register number = 42101</b>		
DC precharge state	3	3
Idle state	4	4
Power track state	5	5
Reserved	6	6
Reserved	7	7
Reserved	8	8
Fault state	9	9
Initialization state	A	10
Disabled state	B	11
Latching fault state	C	12
Cool down state	D	13

The following table contains the bitmap information for the PVM status register. The response values for this command are shown in the table as both hex and decimal values. When multiple codes are set, the resulting status word value will be a sum of the individual code values.

**Table 6-17.** PVM status register status code values

Description	Hex Value	Decimal Value	Notes
<b>Modbus register number = 42005</b>			
OK	0	0	
Rebooting	1	1	
Inverter communication fault	2	2	Results in return value of zero for reads of data registers listed in <a href="#">Table 6-14</a> on page 6-22.
Web post fault	4	4	
DNS server fault	8	8	
Real time clock error	10	16	The battery is dead or cannot synchronize with the network time server.

*Table 6-17. PVM status register status code values (Continued)*

Description	Hex Value	Decimal Value	Notes
<b>Modbus register number = 42005</b>			
Wrong communications firmware	20	32	Incompatible or incorrect revision of communications firmware.
Modbus address error	40	64	Failed reading the Modbus address switches.

## Modbus Command Registers

*Table 6-18. Modbus command registers*

Description	Start Register	End Register	No. of Registers	Modbus Address	Data Type	Notes
<b>Modbus base address = 3000</b>						
Clear fault command	3000	3000	1	43001	UINT16	Range = CF hex Write this value to clear faults and try a restart.
Disable inverter	3001	3001	1	43002	UINT16	Write values: <ul style="list-style-type: none"> <li>• 0xDD to disable</li> <li>• 0xEE to enable</li> </ul> Reading this register returns: <ul style="list-style-type: none"> <li>• 0 after bootup</li> <li>• 0xDD after a disable</li> <li>• 0xEE after an enable command is sent</li> </ul>

**Table 6-18. Modbus command registers (Continued)**

Description	Start Register	End Register	No. of Registers	Modbus Address	Data Type	Notes
<b>Modbus base address = 3000</b>						
Enable inverter	3002	3002	1	43003	UINT16	Write values: <ul style="list-style-type: none"><li>• 0xDD to disable</li><li>• 0xEE to enable</li></ul>
Reset data comm section	3003	3003	1	43004	UINT16	Write 0x99 to this register to reset the communication interface PCB.

### Related Links

- “[Troubleshooting Warnings and Faults](#)” on page 8-2



# Maintenance

**WARNING:**

These servicing instructions are for use by qualified personnel only. To reduce the risk of electric shock, do not perform any servicing other than that specified in the operating instructions.

**AVERTISSEMENT:**

Ces instructions d'entretien sont destinées uniquement à un personnel qualifié. Pour réduire le risque d'électrocution, ne pas effectuer un entretien autre que celui spécifié dans les instructions de fonctionnement.

**WARNING:**

Maintenance personnel must receive proper training before installing, troubleshooting, or maintaining high-energy electrical equipment. Potentially lethal voltages could cause death, serious personal injury, or damage to the equipment. Ensure that all appropriate safety precautions are taken.

**AVERTISSEMENT:**

Le personnel d'entretien doit recevoir une formation appropriée avant d'installer, de dépanner ou d'entretenir un équipement électrique à haute énergie. Des tensions potentiellement mortelles pourraient provoquer la mort, des blessures graves ou des dommages à l'équipement. S'assurer que toutes les consignes de sécurité appropriées ont été respectées.

Routine maintenance of the AE inverter should be performed according the maintenance schedule in this manual in order to maintain the overall performance of the unit. Some maintenance procedures are required every five, ten, fifteen, and twenty years from point of installation.

The user manual includes maintenance procedures that you can perform without specialized equipment.

## VISUAL INSPECTION



### DANGER:

Risk of electrical shock. High voltages are present in the inverter cabinet. Both AC and DC disconnects must be in the OFF position when working on the unit. Wait five minutes to discharge high voltage before opening the front panels of the inverter.



### DANGER:

Risque d'électrocution. L'intérieur de l'onduleur est soumis à des hautes tensions. Les interrupteurs de courant alternatif et continu doivent être mis HORS TENSION durant les travaux sur l'unité. Attendez cinq minutes afin de permettre la décharge du courant haute tension avant de démonter les panneaux avant de l'onduleur.



### DANGER:

RISK OF DEATH OR BODILY INJURY. Disconnect and lockout/tagout all sources of input power before working on this unit or anything connected to it.



### DANGER:

RISQUE DE MORT OU DE BLESSURES CORPORELLES. Débrancher et verrouiller/étiqueter toutes les sources de puissance d'entrée avant de travailler sur cette unité ou sur tout élément qui y est raccordé.

AE recommends visually inspecting the inverter every time it is serviced. Start by observing the front, back, and sides of the inverter for damage, foreign objects, or dust and debris that may have accumulated around the inverter. Remove dirt and debris from the area around the inverter at least every six months.

## MAINTENANCE SCHEDULE

The following maintenance should be performed annually by a qualified service person. Please refer to AE's Terms and Conditions of Sale for warranty-related items. Complete the maintenance checklist below save the information for your records.

**Table 7-1. Maintenance checklist**

Item #	Check or Procedure	Annual Maintenance
<b>A</b>	<b>General inspection and cleaning</b>	
1	Record general site conditions.	X
2	Record inverter performance data from inverter display.	X
3	Record environmental conditions.	X
4	Remove dirt and debris from underneath the inverter.	X
5	Inspect and clean interior of inverter.	X
6	Inspect air filter and clean or replace.	X
7	Confirm presence of product documentation.	X
<b>B</b>	<b>Connections and wiring</b>	
8	Complete visual inspection of electrical connections and wiring.	X
9	Complete mechanical inspection of connections and wiring.	X
10	Measure torque of all electrical connections and re-torque as needed.	X
11	Complete thermal scan of inverter connections, wiring and electronics.	X
<b>C</b>	<b>Testing</b>	
12	Confirm the inverter operating modes including standby, startup and on.	X
13	Check operation of protective circuits and alarms.	X
14	Validate display data accuracy.	X
<b>D</b>	<b>Repair or replace</b>	
15	Repair or replace items that have been determined to be near the end of their useful life.	X
<b>E</b>	<b>Reporting</b>	
16	Complete preventative maintenance report and recommendation.	X

## REPLACEMENT PARTS

Contact Solar Energy Technical Support for information on obtaining replacement parts.

*Table 7-2. Inverter replacement parts*

Part	Replacement Schedule
Door seal gaskets	5 years
Battery (CR1216)	When a Real Time Clock error occurs in Modbus PVM status register 42005.
Air filters	As needed
Card cage filter	As needed

## CHECKING AND REPLACING THE AIR FILTERS

As part of preventative maintenance, every 12 months you should perform regular checks of the self-contained cooling system to determine if the air filters need to be replaced. Cleaning may be required more often depending on the location of the inverter or the air filters might need to be replaced.

### Maintaining the Air Filters

#### TOOLS REQUIRED

- Flat-head screwdriver
- 5/32" Allen wrench

#### TO MAINTAIN THE AIR FILTERS

The air intake hoods are mounted on gas shocks. The hoods must be in the open position to clean the filters.

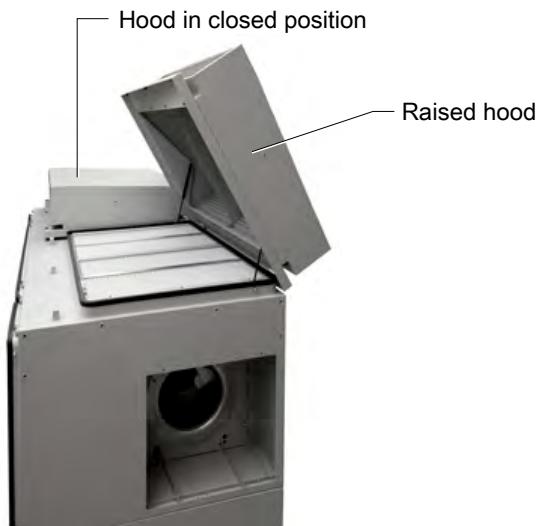
1. Shutdown the inverter prior to starting this procedure and wait five minutes.
2. Using a flat-head screwdriver, turn each of the six retainer tabs a three-quarter turn. The air intake hoods can now be lifted to the open position.



**Figure 7-1.** Air intake hoods

3. Remove the filters using a 5/32" Allen wrench.
4. Clean the filters by vacuuming or blowing out using an air hose with a diffuser.

If there is significant accumulation of dust or particulate matter within the filter fabric, areas of visible blockage to air flow, or physical damage, replace the affected filters.



**Figure 7-2.** Air intake hood in raised position

5. Inspect the filter frames for damage.

Contact AE Solar Energy Technical Support if you wish to replace the filters or frames.

6. Close and secure the hoods before resuming normal operation of the unit.

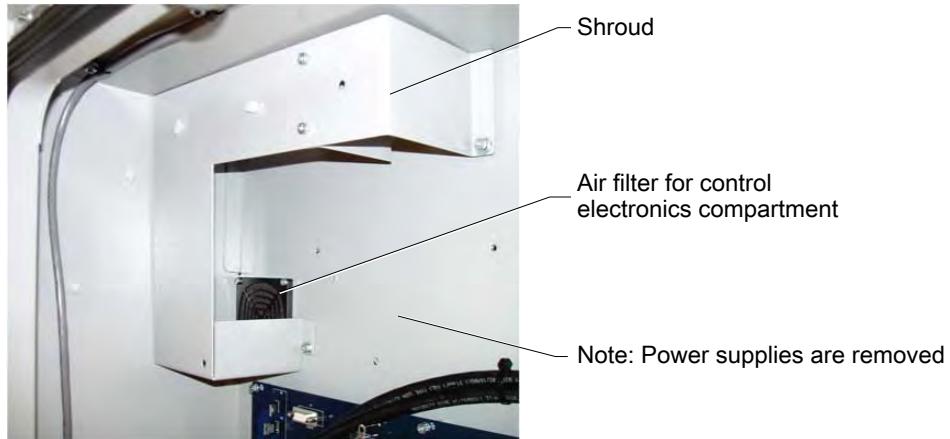
## Maintaining the Card Cage Air Filter

### TO MAINTAIN THE CARD CAGE FILTER

The card cage features a secondary air filter to ensure long PCB life. The card cage air filter is located under the intake air shroud above the card cage located in the upper right compartment.

Use the following instructions to access the secondary air filter for the card cage.

1. Shutdown the inverter and wait five minutes prior to starting this maintenance procedure.
2. Remove the air intake shroud next to the power supplies. This will expose the air filter.



*Figure 7-3. Card cage air filter*

3. Remove the four screws on the card cage air filter.
4. Remove the filter.
5. Clean the filter with compressed air.
6. Replace the filter and secure with the screws.

If the filter needs to be replaced, contact AE Solar Energy Technical Support.

7. Replace the shroud.

## REPLACING THE BATTERY ON THE COMMUNICATIONS PCB

### Parts Required

- Battery: Part number CR1216

## To Replace the Battery

Use the following instructions to access the battery.

1. Shutdown the inverter and wait five minutes before starting.
2. Remove the communications PCB from the card cage in the data monitoring compartment.
3. Remove the battery located in the lower right section of the PCB by pushing the battery up from the lower right corner of the battery.
4. Insert a new battery with the positive side facing out.
5. Reinsert the communications PCB in the card cage.
6. Close and secure the door on the data monitoring compartment.



# Troubleshooting and Solar Energy Technical Support



## WARNING:

Maintenance personnel must receive proper training before installing, troubleshooting, or maintaining high-energy electrical equipment. Potentially lethal voltages could cause death, serious personal injury, or damage to the equipment. Ensure that all appropriate safety precautions are taken.



## AVERTISSEMENT:

Le personnel d'entretien doit recevoir une formation appropriée avant d'installer, de dépanner ou d'entretenir un équipement électrique à haute énergie. Des tensions potentiellement mortelles pourraient provoquer la mort, des blessures graves ou des dommages à l'équipement. S'assurer que toutes les consignes de sécurité appropriées ont été respectées.

Before calling AE Solar Energy Technical Support, perform recommended checks and troubleshooting procedures. If you are still unable to resolve faults or warnings and resume normal operation after following these checks and procedures, contact AE Solar Energy Technical Support.

## TROUBLESHOOTING LAN CONNECTIVITY

Most connectivity problems relate to wiring issues or corporate security settings blocking the inverter from accessing the Internet.

Wiring problems are usually caused by the following:

- Result of a poor crimp
- Wire that exceeds 320 ft. as specified in the installation of the inverter
- Pinched wires somewhere between the inverter and the hub or router

Corporate network problems will require support from your corporate IT department where the inverter is installed. The most common problem is the inverter has not been provided with DHCP server access using port 443 or the static IP address has not been set.

Troubleshooting communications issues can also be accomplished using the four LED lights on the communications PCB.

## To Test the LAN Cable

AE recommends using pre-made cables whenever possible. If a cable must be hand-crimped, we recommend:

- Test the cable with a cable tester such as a Fluke LinkRunner™ Pro Network Multimeter (LPRO1000).
- Verify the cable's integrity by connecting a laptop to the cable at the inverter and verify it has access to the Internet.
- Verify the inverter's MAC address has been assigned an IP address by the network.

## TROUBLESHOOTING WARNINGS AND FAULTS



### **WARNING:**

Maintenance personnel must receive proper training before installing, troubleshooting, or maintaining high-energy electrical equipment. Potentially lethal voltages could cause death, serious personal injury, or damage to the equipment. Ensure that all appropriate safety precautions are taken.



### **AVERTISSEMENT:**

Le personnel d'entretien doit recevoir une formation appropriée avant d'installer, de dépanner ou d'entretenir un équipement électrique à haute énergie. Des tensions potentiellement mortelles pourraient provoquer la mort, des blessures graves ou des dommages à l'équipement. S'assurer que toutes les consignes de sécurité appropriées ont été respectées.



### **DANGER:**

This unit contains energy storage devices that take up to 5 minutes to discharge. Verify the high energy capacitors are completely discharged before working on this unit.



### **DANGER:**

Cette unité contient des dispositifs de stockage d'énergie qui prennent jusqu'à 5 minutes pour se décharger. Vérifier que les condensateurs à haute énergie sont complètement déchargés avant de travailler sur l'unité.

The inverter's display screen is the primary indicator of a possible problem with the inverter. The inverter can detect and display inverter warnings and faults.

Before performing advanced troubleshooting, the inverter must be de-energized.

Prior to conducting the following troubleshooting steps, perform a visual inspection to check for the following:

- Loose or disconnected wires
- Fuses
- Other connections
- Hardware issues

If the visual inspection reveals potentially unsafe conditions, discontinue troubleshooting and contact AE Solar Energy Technical Support or email [invertersupport@aei.com](mailto:invertersupport@aei.com) prior to proceeding.

## Troubleshooting Warnings

Warnings are displayed if a condition is detected that does not require the inverter to shut down but may require attention. The following screen is a sample warning screen.



4654

*Figure 8-1. Warning screen*

## SYSTEM WARNINGS

The following table lists the system warnings.

**Table 8-1. Inverter system warnings**

Hexadecimal Value	Display String	Description	Action
0001	FAN 1 WARNING	Fan 1 warning	Contact Solar Energy Technical Support
0002	FAN 2 WARNING	Fan 2 warning	
0008	MAG HITEMP WARNING	Magnetics high temperature warning	
0010	HI TEMP PWR LIMIT	Power foldback warning	
0020	DELTA TEMP WARNING	Heatsink delta temperature warning	
0080	GFDI CURRENT WARNING	GFDI current warning	
0100	AC SURGE WARNING	AC surge warning	
0200	DC SURGE WARNING	DC surge warning	
0400	DC CURRENT WARNING	Negative DC current warning	
0800	IPM CURRENT WARNING	IPM current warning	
1000	PS 24V WARNING	24 V power supply warning	
2000	DC BLEED WARNING	DC bleed circuit warning	

## Troubleshooting Inverter Faults

If a fault has occurred the inverter will cease power production until the fault is cleared. A fault may be a latching or non-latching fault.

- Non-latching: Automatically clears if the fault condition is resolved and the inverter automatically restarts after completing its startup sequence.
- Latching: Requires manual intervention to restart the inverter.

If the inverter has faulted, the display screen will show the corresponding fault information in a series of three or more screens. The display will then cycle back through the three screens.

- First screen: Displays the fault category followed by the hexadecimal fault code(s) value.
- Second screen: Displays a text description of the fault code(s).
- Third screen: Displays Solar Energy Technical Support contact information.

In the following example, a system fault, SYS returned a code, indicating too many fault restarts occurred. The 0000 indicates no fault occurred in the other fault groups.

Fault Codes  
SYS 0020 DRV 0000  
VLT 0000 TMP 0000  
GRD 0000

Screen 1: Fault code(s)

Fault  
AC FAST UNDERVOLT A  
GFDI FAULT

Screen 2: Fault text

Advanced Energy  
phone: (877)312-3832  
email: [invertersupport@aei.com](mailto:invertersupport@aei.com)

Screen 3: Contact information

**Figure 8-2.** Screen sequence when an inverter faults

## AC UNDER VOLTAGE FAULT

### To Identify an AC Under Voltage Fault

If the inverter displays an AC Under Voltage fault and all the voltages going into the inverter are within the tolerances provided in the specifications, continue with the following troubleshooting tips.

1. Check the main branch circuit breaker.
  - a. If the breaker is not tripped:
 

Check the small fuses located on the AC panel. If one or more of these fuses have opened, replace them with like parts (600 VAC, 7.5 A as required)
2. If any of the fuses are open, visually inspect the wiring. Look for the following:
  - a. Frayed wires or carbon marks indicating a short
  - b. Burned traces on the PCBs

If any of these conditions are present, DO NOT START THE INVERTER. Contact AE Solar Energy Technical Support for replacement parts or service.

## GROUND FAULTS

The inverter is equipped with a Ground Fault Detector Interrupter (GFDI). The purpose of the GFDI is to detect a ground fault (unintended current flow from the solar panels to earth ground) and in this event, disable the inverter.



### WARNING:

For the GFDI circuit to function as designed, the solar array safety ground must not be connected to the PV array positive or negative leads. Bonding the safety ground to the grounded leg of the array anywhere but through the inverter will cause the GFDI circuit to be bypassed. This would defeat the operation of the GFDI and potentially create an unsafe operating condition.

**AVERTISSEMENT:**

Pour que le circuit GFDI fonctionne normalement, la prise de terre de sécurité du système PV ne doit pas être branché aux câbles positifs ou négatifs des piles PV. Brancher la prise de terre de sécurité au pied des piles ou à toute autre partie que l'onduleur causerait une mise hors circuit du GFDI. Ceci ne empêcherait le fonctionnement normale du circuit GFDI et créerait des conditions de fonctionnement potentiellement dangereuses.

The GFDI functions using a 5 A fuse to connect or bond the solar array negative (or the solar array positive, if using a positively grounded panel array) to earth ground on the DC subcombiner panel. If the ground fault current exceeds 5 A between the grounded array terminal and the earth ground, the GFDI fuse will open and disconnect the solar panels from their ground reference, interrupting the ground fault. In this situation, the inverter will cease operation and show a ground fault message on the inverter display.

### To Identify the Cause of a Ground Fault

1. Turn the ON/OFF switch on the display to the **OFF** position.
2. Turn the AC disconnect to the power OFF position.

The display on the upper front panel should be inactive.

3. Identify the cause of the ground fault by checking the following items:
  - a. A configuration error during commissioning.
  - b. Switching the grounded conductor in the DC disconnect.
    - For a negatively grounded system, the positive leg should be broken in the DC disconnect.
    - For a positively grounded system, the negative leg should be broken in the DC disconnect.
  - c. A pinched wire in the installation connecting some part of the array or DC wiring to earth ground.
  - d. Mismatched array strings in a multiple inverter installation.

### TO RESOLVE A GROUND FAULT

**DANGER:**

This unit contains energy storage devices that take up to 5 minutes to discharge. Verify the high energy capacitors are completely discharged before working on this unit.

**DANGER:**

Cette unité contient des dispositifs de stockage d'énergie qui prennent jusqu'à 5 minutes pour se décharger. Vérifier que les condensateurs à haute énergie sont complètement déchargés avant de travailler sur l'unité.

**DANGER:**

Verify that no shock hazard exists between both fuse terminals and earth ground before removing the fuse. A 600 V rated fuse pulling device is required.

**DANGER:**

Vérifier qu'il n'y a aucun risque d'électrocution entre les deux bornes de fusible et la prise de terre avant de retirer le fusible. Un arrache-fusible d'une capacité de 600 V est requis.

1. Open the control electronics compartment and locate the GFDI fuse on the backplane PCB.
2. Inspect the 5 A GFDI fuse for continuity using a multimeter.
  - If the fuse is not open, continue troubleshooting using the steps below.
  - If the fuse is open, a ground fault exists outside the inverter. Refer to the instructions for resolving an external ground fault.
3. Remove the GFDI fuse.
4. Check for continuity (ohms) across the GFDI fuse.

If the meter indicates no continuity then a ground fault likely exists.

- Check the DC voltage between the grounded terminal of the array and earth ground. The voltage should be less than 30 volts with the GFDI fuse removed. If the voltage is higher than 30 volts, a ground fault likely still exists. Check the array wiring. For the best results, perform this test with the DC disconnect in both the ON and OFF positions.
- Make sure the grounded leg of the solar array is not disconnected inside the DC disconnect compartment.

5. Once the ground fault condition has been eliminated, verify the voltage between earth ground and the grounded side of the PV array is less than 30 volts.
6. Ensure the DC disconnect is in the OFF position and install the new GFDI fuse.
7. Restart the inverter.

### Related Links

- “System Startup Procedure” on page 5-1

## INVERTER FAULT CODES

The inverter display screen provides fault information. In addition, the inverter firmware utilizes a Modbus variable to indicate a fault condition. Each bit in this fault variable represents a fault type, the same fault type displayed on the screen. The Modbus information for the bit assignments and specific fault variables for the fault categories are as follows:

*Table 8-2. Fault categories*

Description	Screen Display Category	Bit Number	Hex Value	Decimal Value
<b>Modbus register number = 42102</b>				
Drive fault	DRV	0	1	1
Voltage fault	VLT	1	2	2
Grid fault	GRD	2	4	4
Temperature fault	TMP	3	8	8
System fault	SYS	4	10	16
Latching fault		15	8000	32768

For each fault category, another fault variable provides detailed information on which fault has occurred within this category. The following tables list the possible faults within each category and related information:

- Hexidecimal value: Value displayed following the category
- Screen display text: Text displayed on the second screen
- Description: Describes the fault
- Action: Necessary steps to resolve the fault

### Drive Faults

The following table lists the drive protection faults.

**Table 8-3. Drive (DRV) faults**

Display Screen Hex Value	Display Screen Text	Description	Action
0001	DRIVE A LOW	Drive protection fault, phase A low	Contact Solar Energy Technical Support
0002	DRIVE A HIGH	Drive protection fault, phase B high	
0004	DRIVE B LOW	Drive protection fault, phase C low	
0008	DRIVE B HIGH	Drive protection fault, phase A high	
0010	DRIVE C LOW	Drive protection fault, phase B low	
0020	DRIVE C HIGH	Drive protection fault, phase C high	
0040	HW OVERCURRENT A	Peak over-current, phase A	
0080	HW OVERCURRENT B	Peak over-current, phase B	
0100	HW OVERCURRENT C	Peak over-current, phase C	
0200	RMS OVERCURRENT A	RMS over-current, phase A	
0400	RMS OVERCURRENT B	RMS over-current, phase B	
0800	RMS OVERCURRENT C	RMS over-current, phase C	
1000	DC OVERVOLTAGE	DC volts over range	
2000	DC UNDERRVOLTAGE	DC volts under range	

### Voltage Faults

The following table lists the voltage faults, including VAC sense, VDC, and power supply faults.

**Table 8-4. Voltage (VLT) faults**

Display Screen Hex Value	Display Screen Text	Description	Action
0001	VAC OVER PEAK A	Peak AC voltage high, phase A	Contact AE Solar Energy Technical Support.
0002	VAC OVER PEAK B	Peak AC voltage high, phase A	
0004	VAC OVER PEAK C	Peak AC voltage high, phase A	
0008	PLL FAULT	Control PLL fault	
0010	AC UNBALANCED FAULT	AC voltages unbalanced	
0020	DC OVER VOLTAGE	DC voltage high	
0040	POWER SUPPLY P5	5 V power supply fault	
0080	POWER SUPPLY P15	15 V power supply fault	
0100	POWER SUPPLY M15	-15 V power supply fault	
0200	POWER SUPPLY 10	10 V power supply fault	
0400	POWER SUPPLY 24	24 V power supply fault	
1000	DC PRECHARGE	DC precharge fault	
2000	PV-DC DELTA	PV input and DC bus voltage delta	

### Grid Faults

The grid faults in the following table include grid interactive voltage and frequency faults.

**Table 8-5. Grid (GRD) faults**

Display Screen Hex Value	Display Screen Text	Description	Action
0001	AC FAST UNDERVOLT A	Fast AC voltage low, phase A	Wait for the grid to stabilize. The inverter cannot operate correctly when the grid voltage is out of range limitations or is unstable.
0002	AC FAST UNDERVOLT B	Fast AC voltage low, phase B	
0004	AC FAST UNDERVOLT C	Fast AC voltage low, phase C	
0008	AC SLOW UNDERVOLT A	Slow AC voltage low, phase A	
0010	AC SLOW UNDERVOLT B	Slow AC voltage low, phase B	
0020	AC SLOW UNDERVOLT C	Slow AC voltage low, phase C	
0040	AC FAST OVERVOLT A	Fast AC voltage high, phase A	
0080	AC FAST OVERVOLT B	Fast AC voltage high, phase B	
0100	AC FAST OVERVOLT C	Fast AC voltage high, phase C	
0200	AC SLOW OVERVOLT A	Slow AC voltage high, phase A	
0400	AC SLOW OVERVOLT B	Slow AC voltage high, phase B	
0800	AC SLOW OVERVOLT C	Slow AC voltage high, phase C	
1000	AC UNDER FREQ	Low frequency fault	
2000	AC OVER FREQ	High frequency fault	

### Temperature Faults

The following table lists the temperature faults.

**Table 8-6. Temperature (TMP) faults**

Display Screen Hex Value	Display Screen Text	Description	Action
0001	HEATSINK TEMP A1	Module heat-sink A1 temperature high	Clean all filters. Make sure air vents aren't blocked and sufficient space is provided around all air vents.  If the filters are clean and air flow is insufficient, contact AE Solar Energy Technical Support.
0002	HEATSINK TEMP A2	Module heat-sink A2 temperature high	
0004	HEATSINK TEMP B1	Module heat-sink B1 temperature high	
0008	HEATSINK TEMP B2	Module heat-sink B2 temperature high	
0010	HEATSINK TEMP C1	Module heat-sink C1 temperature high	
0020	HEATSINK TEMP C2	Module heat-sink C2 temperature high	
0040	BOARD TEMP HI	Control board temperature high	
0080	DRIVE TEMP LOW	Drive temperature low	
0100	MAGNETICS TEMP HI	Magnetics temperature high	
0200	AMBIENT TEMP LOW	Ambient temperature low	
0400	MAG TEMP LOW	Magnetics temperature low	
0800	IPM TEMP HIGH	IPM temperature high	

### System Faults

The following table lists the miscellaneous system faults.

**Table 8-7. System (SYS) faults**

Display Screen Hex Value	Display Screen Text	Description	Action
0001	GROUND FAULT	Ground fault	Check the PV array field wiring.
0002	AC CONTACTOR	AC contactor fault	
0004	DC CONTACTOR	DC contactor fault	

**Table 8-7. System (SYS) faults (Continued)**

Display Screen Hex Value	Display Screen Text	Description	Action
0008	WD TIMER	Watchdog fault	Contact AE Solar Energy Technical Support for service.
0010	CPU LOAD	CPU load fault	
0020	RESTART LIMIT	Too many fault restarts	
0040	CONFIGURATION	Configuration fault	
0080	CURRENT IMBALANCE	AC current imbalance	
0100	AC VOLTAGE SENSE	No AC voltage detected	
0800	DISCONNECT OPEN	Disconnect open	
1000	DC MISWIRE	DC mis-wired for configured grounding	

## PCB STATUS LEDS

The AE commercial inverter includes status LEDs to help troubleshoot system operation. The status LEDs are located on the following PCBs:

- Controller PCB
- Communications interface PCB

### Controller PCB Status LEDs

There are two LEDs on the front of the controller PCB, a green and a red LED.

**Table 8-8. Controller PCB LEDs**

LED Color	Flash Code	LED Sequence / Unit Status	Action
Green	Solid	Inverter is on and ready to produce power.	None

**Table 8-8. Controller PCB LEDs (Continued)**

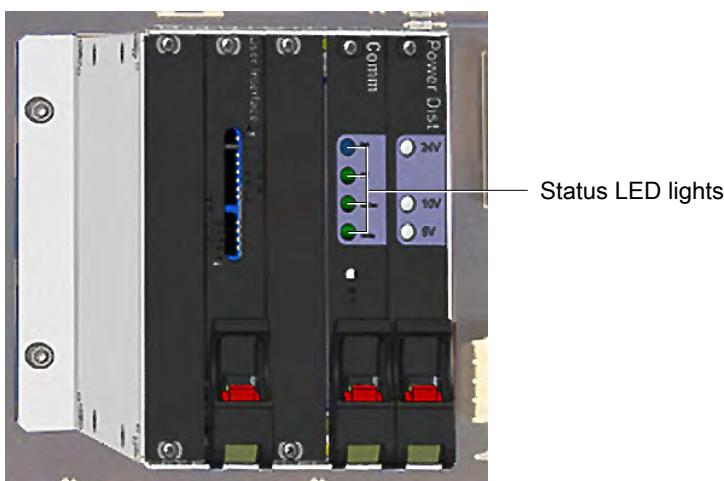
LED Color	Flash Code	LED Sequence / Unit Status	Action
Red	Solid	The inverter is in a faulted condition.	<ul style="list-style-type: none"> <li>Check the fault code on the display screen</li> <li>Clear the fault condition</li> <li>Inverter will auto reset</li> </ul>
	Flashing	A latching fault has occurred.	<ul style="list-style-type: none"> <li>Check the fault code on the display screen</li> <li>Manually clear the fault condition</li> <li>Restart the inverter</li> </ul>

## Communication PCB Status LEDs

The communication PCB includes four status LEDs.

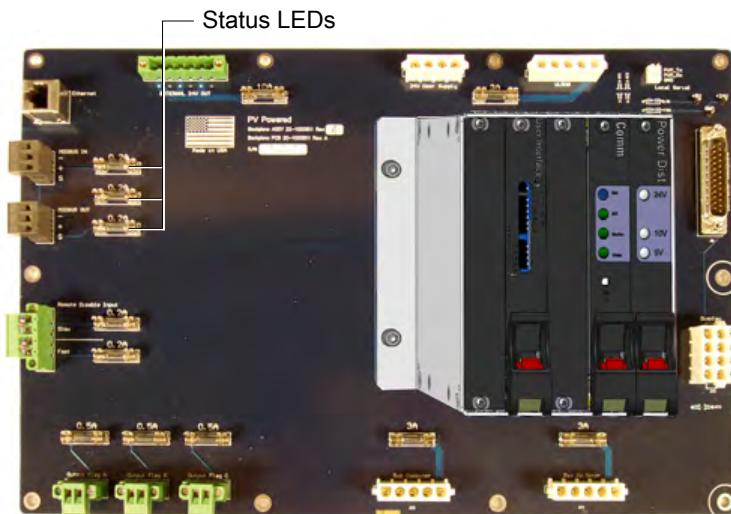
- Link: Indicates presence of a hardware Ethernet connection
- Activity (or ACT): Indicates internet traffic
- Status: Indicates the communication status
- Modbus: Indicates activity on the Modbus network

The four LEDs primary location is on the face of the communication PCB in the data monitoring card cage on the left side of the power module assembly as shown in the following figure.



**Figure 8-3. Communication PCB with status LEDs**

The other set of LEDs are on the communication interface PCB located in the data monitoring section in the front upper left of the inverter. These four LEDs are surface mount LEDs located near the Ethernet and Modbus connector as shown in the following figure. These LEDs are redundant and are synchronized with communication PCB.



**Figure 8-4.** Communication interface PCB with LEDs

**Table 8-9.** Link LED

LED Color	Flash Code	Unit Status / Description	Action
Amber	On	Hardware Ethernet connection is found	None
	Off	No hardware Ethernet connection available	None

**Table 8-10.** Activity LED

LED Color	Flash Code	Unit Status / Description	Action
Green	Flashes	Continuous flash to indicate the presence of internet traffic	None
	Solid	May be solid in the presence of heavy internet traffic	None

**Table 8-11. Status LED**

LED Color	Flash Code	Unit Status / Description	Action
Green	On	<p>Serial communication is established. Inverter communications are operating normally.</p> <ul style="list-style-type: none"> <li>On solid for a few seconds</li> <li>Followed by quick flashes for several seconds while the communications device looks for an Internet connection</li> <li>After a few seconds flashes more slowly while serial communication is established with the inverter's main processor</li> <li>Remains on unless a fault occurs</li> </ul>	None
	Short-long-short	<p>Serial communication fault. The communication PCB is communicating with the inverter's main processor via serial communication. If the communication PCB cannot establish communication with the main processor, the serial communication fault code will flash. It is normal for this status code to flash for a few seconds during startup.</p>	None
	Long-short-short	<p>DNS failure. The inverter attempts to post data once every 15 minutes to the AE database using Domain Name Service (DNS) server to resolve the IP address. The DNS failure code will flash when:</p> <ul style="list-style-type: none"> <li>DNS server cannot be found</li> <li>Invalid IP address returned</li> </ul> <p>If this post succeeds, the LED returns to normal operation until the next post attempts to connect to the DNS server.</p>	<ul style="list-style-type: none"> <li>Verify the IP address is valid.</li> </ul>

**Table 8-11. Status LED (Continued)**

LED Color	Flash Code	Unit Status / Description	Action
	Short-Short-Long	<p>Network connection fault. The inverter cannot post data to the AE database server. The status LED may indicate normal operation before this occurs. This can happen in the following circumstances:</p> <ul style="list-style-type: none"> <li>• Network cable is not connected</li> <li>• Network does not have a DHCP server or the DHCP server did not provide a valid IP address to the inverter</li> <li>• AE server is down for maintenance</li> <li>• Any other network problem that does not allow data to post to the AE server</li> </ul>	<ul style="list-style-type: none"> <li>• Verify network cable is connected.</li> <li>• Verify the IP address is valid.</li> </ul>

**Table 8-12. Modbus LED**

LED Color	Flash Code	Unit Status / Description	Action
Green	Short (1/8 sec.)	<p>Enables the installer to troubleshoot the system by verifying that communications are occurring on the network, indicating the following:</p> <ul style="list-style-type: none"> <li>• If the inverter is connected as a slave device, the LED flashes quickly whenever there is activity on the network</li> <li>• Modbus network commands occurring but are not addressed to this specific inverter</li> </ul>	<ul style="list-style-type: none"> <li>• Check the Modbus address switches and make sure they correspond to the address programmed into the Modbus master.</li> <li>• Confirm that the baud rate and other communication parameters of the Modbus master are set correctly.</li> </ul>
	Long (1/2 sec.)	Inverter sees and responds to a Modbus master request message that is addressed to this specific inverter.	None
	Short and long	Communication occurring on a Modbus network that contains multiple Modbus slave devices.	None

## AE SOLAR ENERGY TECHNICAL SUPPORT

Please contact AE Solar Energy Technical Support if you have questions or problems that cannot be resolved by working through the provided troubleshooting. When you call Solar Energy Technical Support, make sure to have the unit serial number and part number. These numbers are available on unit labels.

**Table 8-13. AE Solar Energy Technical Support 24 X 7 contact information**

Office	Contact
AE Solar Energy Technical Support  20720 Brinson Blvd Bend, OR 97701 USA   <b>Important</b> For returns and repairs, please call Solar Energy Technical Support to request an RMA and obtain the correct shipping address.	Phone (24 hrs/day, 7 days/week):  Inside the U.S., call 877.312.3832 or Outside the U.S., call +1.541.323.4143  Email: (We will respond to email by the next business day.)  invertersupport@aei.com
If you would prefer to contact a local or regional sales or service office, visit the Advanced Energy web site for current contact information (click on Sales and Support): <ul style="list-style-type: none"><li>• <a href="http://www.advanced-energy.com">http://www.advanced-energy.com</a></li></ul>	

# Specifications

## PHYSICAL SPECIFICATIONS

*Table 9-1. Physical specifications*

Description	Specification
<b>General physical specifications</b>	
Enclosure rating	NEMA 4
Construction	Powder-coated steel with hot-dipped zinc base
Size	2520 mm x 3043 mm x 1240 mm 99.2" x 119.8" x 48.8"
Maximum weight	8,800 lbs
Clearance	Front: 36" Rear: 24" Sides: 36" and 36" Top: 27.5"
<b>User Interface and Communications Protocol</b>	
Display	VFD 4 rows x 20 characters
RS-485	Screw terminal block
Ethernet	IP over Ethernet

## ELECTRICAL SPECIFICATIONS

The table lists electrical specs for the following inverter models:

- PVP500kW (480 VAC)

Note the following limits:

- Accuracy limit of voltage and energy production measurements:  $\pm 5\%$
- Accuracy limit of frequency measurement:  $\pm 0.1$  Hz

**Table 9-2. Electrical specifications**

Description	Specification
<b>AC Characteristics</b>	
Continuous AC power	PVP500kW: 500 kW
Grid type	Three phase, four wire wye (not compatible with delta service)
Nominal AC voltage (VAC)	480 VAC models: 480 wye
Maximum output fault current and duration (also known as the maximum fault current contribution)	PVP500kW: 891.4 A rms at 480 VAC, 3.32 ms
Maximum utility backfeed current	PVP500kW: 3782.0 A rms at 480 VAC, 32 ms
AC maximum continuous current	PVP500kW: 480 VAC: 608A
CEC efficiency	PVP500kW: 480 VAC: 97.0%
Peak efficiency	PVP500kW: 480 VAC: 97.8%
Frequency range	59.3 Hz to 60.5 Hz
AC voltage range set points (default)	(-12% to +10%)
AC operating range	480 VAC models: 423 VAC to 528 VAC
Power factor at full power	> 0.99
Total Harmonic Distortion	< 3%
Standby losses	PVP500kW: < 80 W
<b>DC Characteristics</b>	
DC input bus bar rating	3500 A
Maximum operating input current	PVP500kW: 1600 A
MPPT range <sup>note 1</sup>	310 V to 595 V
Maximum voltage at open circuit	600 V <sub>OC</sub>
Startup voltage	330 V
Startup power	PVP500kW: 1100 W
note <sup>1</sup> At unity power factor and nominal AC voltage.	

**Table 9-3. Utility interconnect voltage and frequency trip limits and times**

<b>Voltage Trip Limits and Times</b>			
The default trip limits and times meet UL1741 anti-islanding requirements.			
Voltage trip limit field adjustment range as a percentage of nominal: -12% to +10%			
Accessible range of trip times: 0.16 s to 300 s (The accuracy limit of time measurement is $\pm 0.1$ s.)			
<b>480 VAC Configurations</b>			
Condition	Factory setting (VAC)	Range (VAC)	Default Trip Time (seconds)
Voltage phase high	304.8	304.8 to 332.5	1.0
Voltage phase low	243.9	216.1 to 243.9	2.0
Voltage phase fast high	332.5	332.5	0.16
Voltage phase fast low	138.6	138.6	0.16
<b>Frequency Trip Limits and Times</b>			
Condition	Factory setting (Hz)	Range (Hz)	Maximum Trip Time (seconds)
Line frequency low	59.3	57.5 to 59.8	0.16
Line frequency high	60.5	60.5	0.16

## Efficiency Specifications

### EFFICIENCY CURVES FOR THE PVP500KW (480 VAC) MODEL

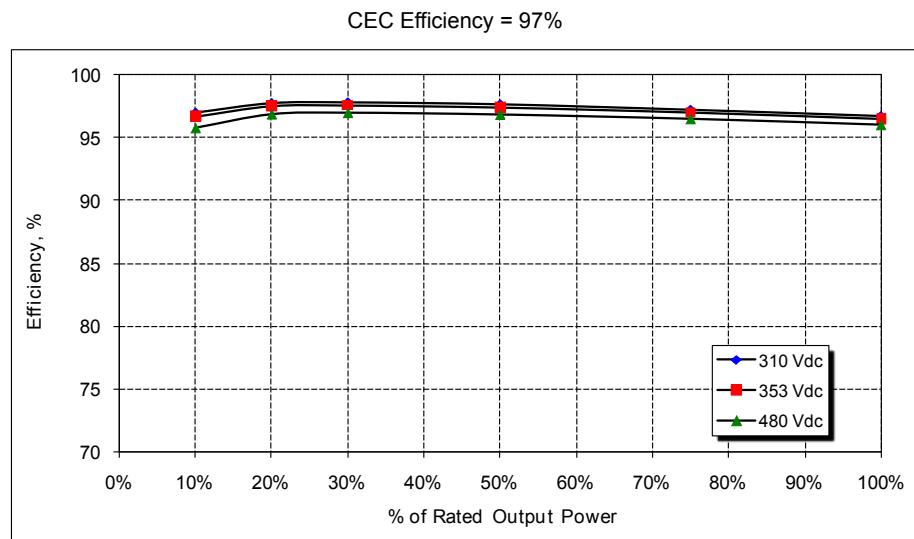


Figure 9-1. Efficiency curves for the PVP500kW (480 VAC) model

Table 9-4. Efficiency specifications for the PVP500kW (480 VAC) model

Input Voltage (VDC)	Power Level in Percent and kW						Weighted	
	10% 50.00	20% 100.00	30% 150.00	50% 250.00	75% 375.00	100% 500.00		
V <sub>MIN</sub>	310	97.5	97.8	97.8	97.7	97.2	96.7	97.4
V <sub>NOM</sub>	353	96.7	97.5	97.6	97.4	97.0	96.5	97.2
V <sub>MAX</sub>	480	95.7	96.8	97.0	96.8	96.5	96.0	96.6

## COOLING SPECIFICATIONS

Table 9-5. Cooling specifications

Description	Specification
Cooling method	Forced convection
Maximum heat rejection rate	78,500 BTU/hr

*Table 9-5. Cooling specifications (Continued)*

Description	Specification
Maximum fan air flow rate	1800 liters per second (3800 CFM)

## ENVIRONMENTAL SPECIFICATIONS

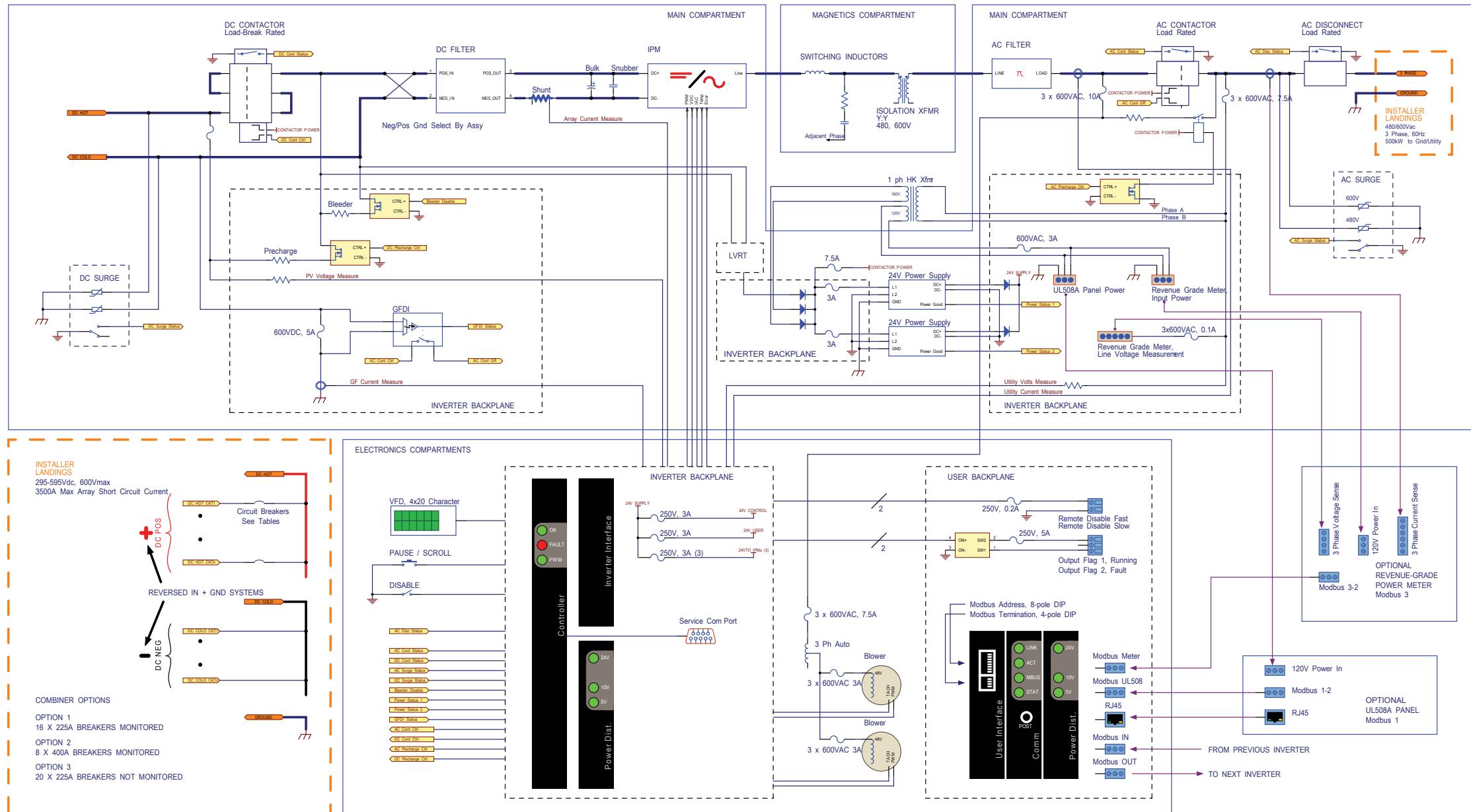
*Table 9-6. Environmental specifications*

Equipment Status	Temperature	Relative Humidity	Air Pressure
Operating	–30°C to +55°C –22°C /–7.6°F to +131°F	0% to 95% non-condensing	Minimum air pressure = 81.2 kPa (812 mbar) Equivalent altitude = 1829 m (6000')
Standby/Storage	–40°C to +60°C –40°F to +140°F	0% to 95% non-condensing	



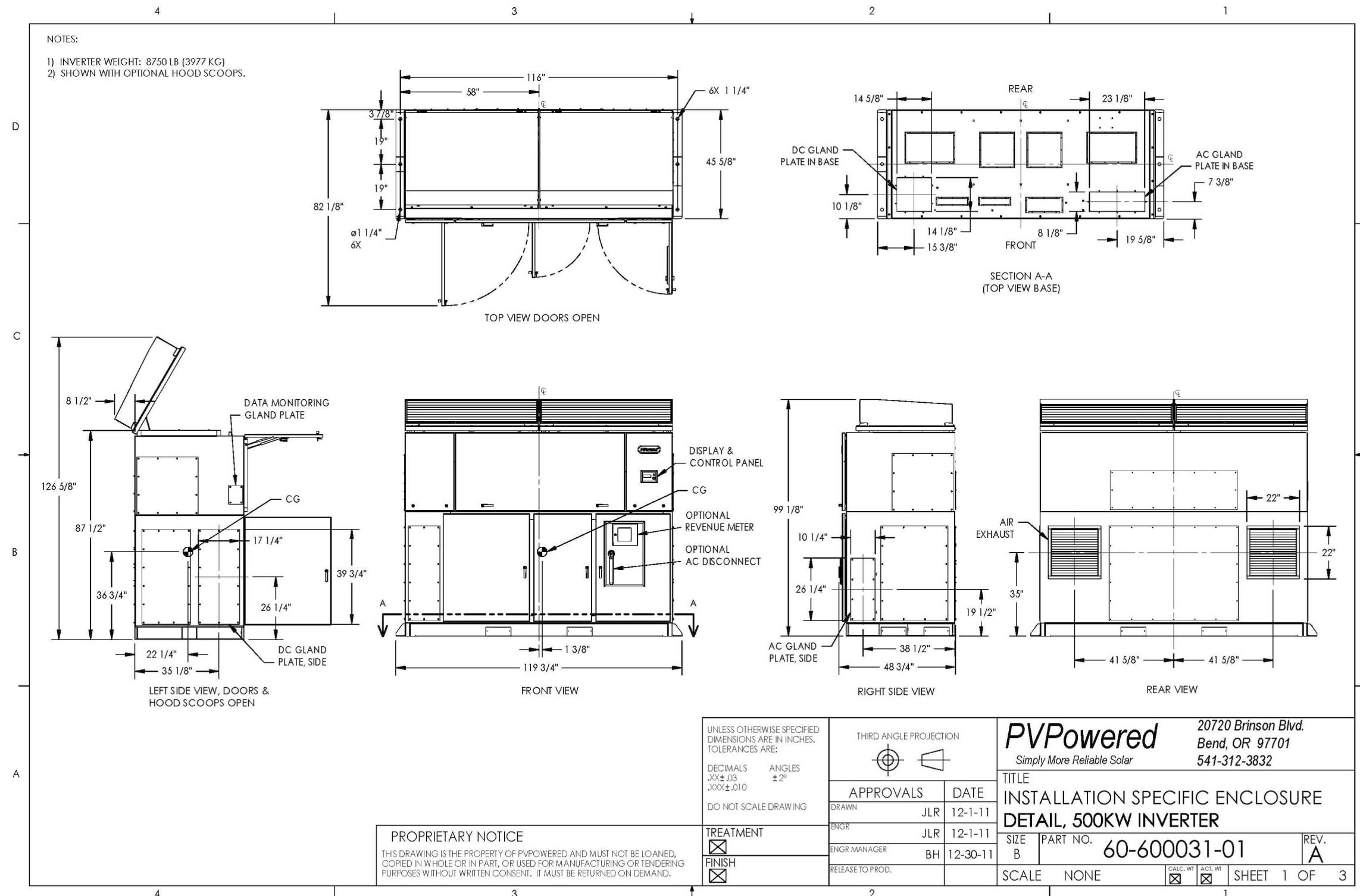
# System and Mechanical Diagrams

# SYSTEM DIAGRAM



**Figure 10-1.** AE 500 system diagram

## MECHANICAL DIAGRAMS



**Figure 10-2.** AE 500 mechanical diagram: View 1

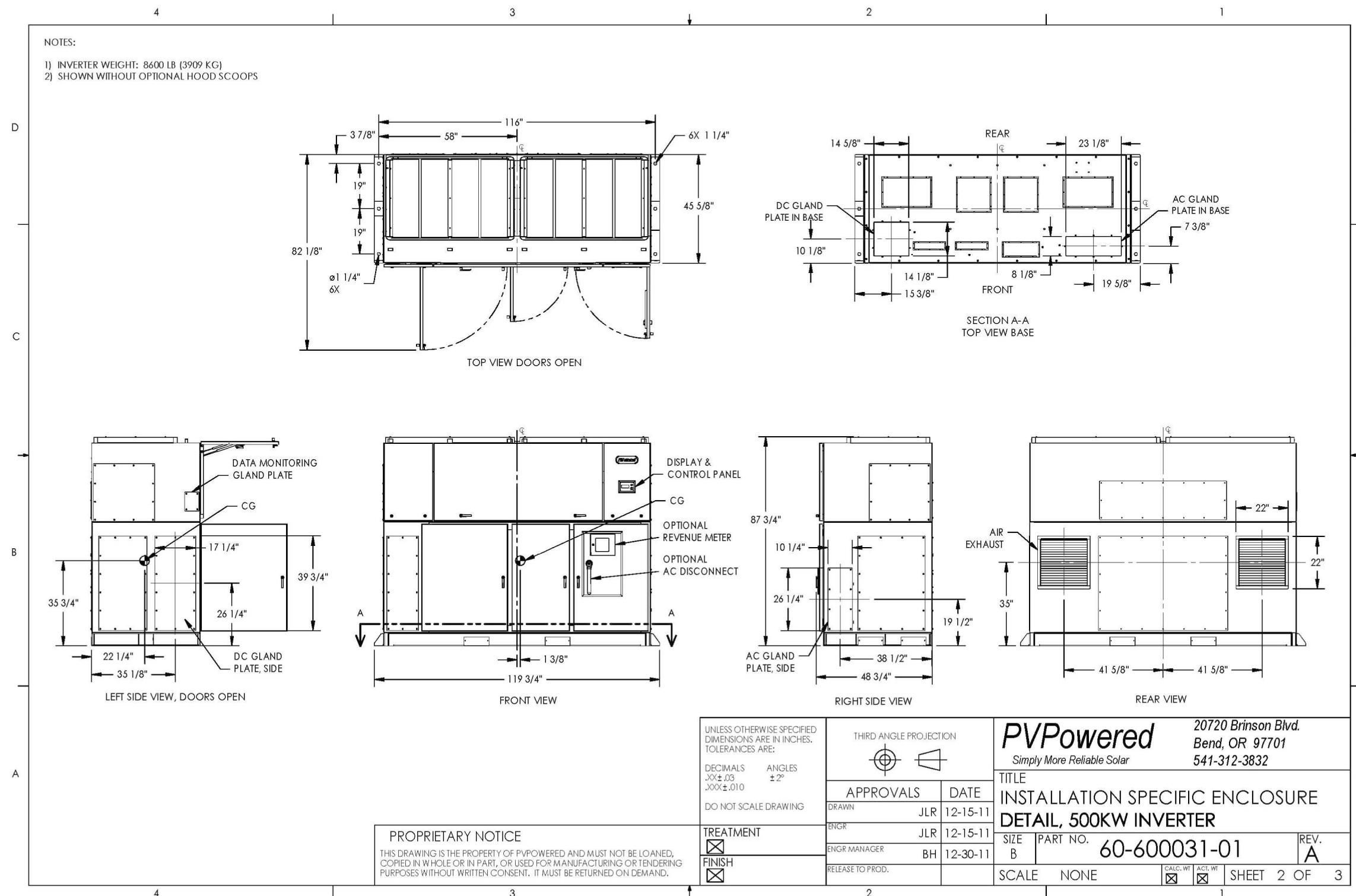


Figure 10-3. AE 500 mechanical diagram: View 2

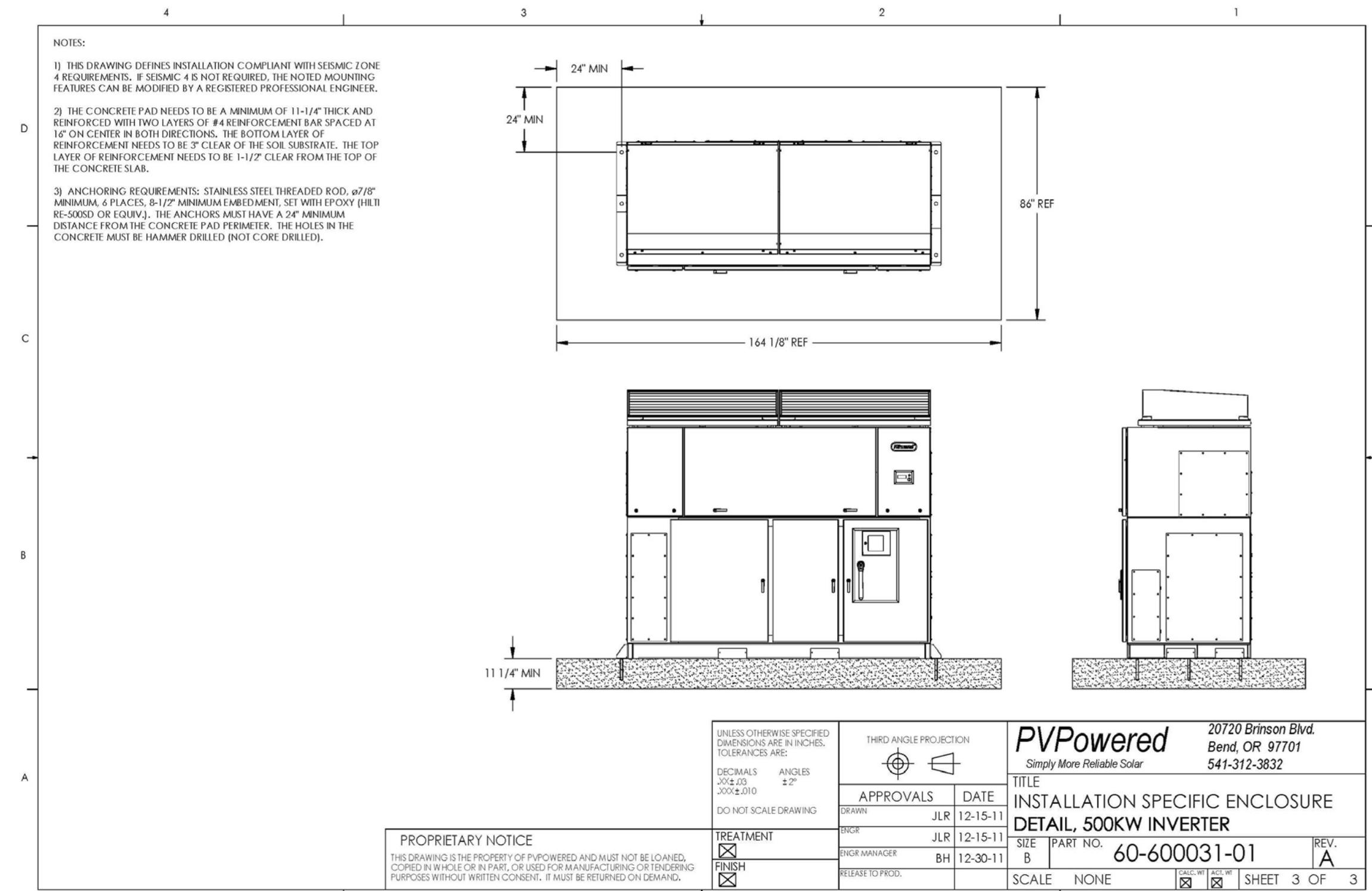


Figure 10-4. AE 500 mechanical diagram: View 3

# Index

## A

AC  
 sub panel 2-8  
 AC/DC interface  
 understanding the 4-16  
 acronyms 1-9  
 address  
 binary conversion table 6-11  
 air filters  
 inspecting 7-6  
 maintenance 7-4  
 air intake hood 2-7  
 position 7-4  
 air intake hoods  
 installing 4-2  
 alert boxes in user manual 1-1  
 amperage  
 wire sizing 4-15

## B

battery  
 replacing 7-3, 7-6  
 bus bar  
 connections 4-6, 4-7, 4-8, 4-15  
 DC inputs 3-7  
 grounding 3-4  
 standard 3-7  
 buttons  
 inverter 2-6

## C

cable  
 backbone 6-9  
 card cage  
 control electronics 2-4  
 inspecting the air filters 7-6  
 PCBs 2-5  
 categories 8-8  
 checklist for maintenance 7-2  
 circuit breaker  
 options 3-7  
 commands  
 Modbus 6-16  
 communications interface PCB  
 Ethernet connection 6-2  
 location of 6-5  
 port 6-8

remote disable 4-25  
 status lights 6-4  
 communications PCB  
 connectivity 8-1  
 replacing the battery 7-6  
 compartment  
 main enclosure 2-3  
 compliance  
 directives and standards 1-5  
 unit 1-4  
 conductor  
 neutral 3-4  
 conductors  
 external 3-3  
 rating 3-3  
 conduit  
 entry location 4-18  
 entry locations 4-22  
 entry points 4-12  
 external 3-3  
 configuring  
 Modbus network 6-6  
 connections  
 bus bar 4-6, 4-7, 4-8, 4-15  
 conduit hubs 4-12  
 electrical 4-15  
 network cable 6-8  
 connectivity  
 communications PCB 8-1  
 DHCP server access 8-1  
 IP address 8-2  
 contact information 8-18  
 control electronics  
 card cage 2-4  
 controls  
 operator interface 2-6  
 cooling  
 inspecting the fan filters 7-4  
 specifications 9-4  
 customer support 8-18

## D

damage  
 in shipping 4-5  
 data  
 types of data, Modbus 6-19  
 data monitoring  
 card cage 2-5

- inverter 3-6
- module 6-1
- DC**
  - combiner sub panel 2-7
  - landing 2-7
  - sub panel 2-7
- DC input voltage
  - calculating 3-7
- DC interface
  - understanding the 4-21
- de-energize
  - procedure 5-9
- definitions 1-9
- DHCP server access
  - connectivity issues 8-1
- diagrams
  - mechanical 10-2
  - system 10-1
- DIP switches
  - remote disable 5-10
- directives 1-5
- disconnect
  - safety 1-5
- display
  - operation of 5-6
- door
  - locking handles 4-6
  - on inverter 4-6
- door gaskets
  - replacing 7-3

**E**

- electrical connections
  - AC/DC terminals 4-15
- electrical specifications 9-1
- electromagnetic compatibility
  - directives and standards 1-5
- environmental
  - cooling requirements 3-4
  - corrosion 3-4
  - heat rejection rate 3-4
- environmental specifications 9-5
- Ethernet
  - cable 6-2
  - cables 6-3
  - connection 6-1

**F**

- fan filters
  - inspecting 7-4
- fans
  - activation of 2-7

- fault codes 8-8
- drive 8-8
- grid 8-10
- system 8-12
- temperature 8-11
- voltage 8-9
- fire
  - prevention 1-8

**G**

- GFDI
  - handling of ground fault 5-6
- gland plates
  - conduit entry 4-12
  - location 3-3
- ground fault
  - identifying 8-5
  - resolving 8-6
  - response to 5-7
- ground fault interrupt device
  - see* GFDI
- grounding
  - bus bar 3-4
  - positive or negative 3-4
  - requirements 3-4
- guidelines
  - safety 1-2

**I**

- icons
  - in user manual 1-1
  - on unit 1-3
- inductor 2-9
- industry guidelines, compliance with 1-5
- inspecting
  - inverter 7-2
- inspection
  - connections 4-7, 4-8
  - fan 4-9
  - filters 4-9
  - screen 4-6, 4-7
  - terminal 4-6, 4-7
  - troubleshooting 8-2
- installation
  - AC/DC interface 4-16
  - clearance 3-2
  - conduit 4-12
  - conduit entry locations 4-18, 4-22
  - DC interface 4-21
  - hoods 4-2
  - lifting and moving 4-1
  - lifting and positioning 4-10
  - location 3-2

- Modbus TCP cable 6-5
- planning 3-1
- requirements 3-1
- weight 3-1
- internet
  - connection 6-1
- inverter
  - AC and DC sub panel compartments 4-7
  - address 6-11
  - air intake hoods 4-2
  - clearance 3-2
  - communications 6-4
  - communications interface 2-5
  - components 2-3
  - connectivity 6-4
  - control electronics 2-4
  - cooling compartment 4-9
  - data monitoring 3-6
  - DC combiner sub panel 2-7
  - DC landing 2-7
  - DC sub panel 2-7
  - de-energize procedure 5-9
  - diagram of 2-3
  - display 2-6, 5-4, 8-2
  - display operation 5-6
  - door 4-6
  - faults 8-4
  - features 2-2
  - gaskets 7-3
  - general description 2-1
  - ground fault 5-7
  - inductor 2-9
  - inspection 4-6
  - lifting and moving 4-1
  - lifting and positioning 4-10
  - magnetics compartment 4-6
  - maximum power point tracking range 2-1
  - models 2-1
  - mounting 4-10
  - operating states 5-2
  - power module compartment 4-8
  - protection system 2-4
  - registering 6-4
  - shutdown procedure 5-8
  - storing 3-2
  - sub panel 2-8
  - transformer 2-9
  - transformers 2-9
  - troubleshooting 8-8
  - weight 3-1
- inverter inspection 7-2
- IP address 6-3
  - assigning 6-6
  - connectivity issues 8-2

J

- jumpers
  - remote disable 4-25

L

- labels on unit 1-3
- LEDs
  - status 8-13
- lifting
  - methods 4-10
- lockout and tagout
  - requirement 1-8

M

- MAC address
  - location of 6-3
- maintenance
  - air filters 7-4
  - checklist 7-2
  - overview 7-1
  - replacement parts 7-3
- maximum power point tracking
  - range 2-1
- mechanical
  - diagrams 10-2
- Modbus
  - address 6-11
  - commands 6-16
  - data types 6-19
  - network biasing 6-11
  - network cable 6-8
  - network settings 6-11
  - network setup 6-6
  - network termination 6-10, 6-11
  - protocol 6-4
  - register mapping assignment 6-19
  - TCP cable installation 6-5
  - TCP network setup 6-4
- monitoring 2-2
  - basic service 6-1
  - remote 2-2
- mounting
  - requirements 4-10

N

- network
  - address 6-11
  - biasing 6-11
  - central inverter settings 6-11
  - configuration 6-6
  - connection 6-2
  - connectivity issues 8-1, 8-13

daisy chain layout 6-7  
length of 6-9  
Modbus termination 6-9  
options 3-6  
shield 6-7  
termination 6-9, 6-10, 6-11  
networkModbus TCP 6-4  
neutral  
grounding 3-4

## O

operating states  
of inverter 5-2  
operation  
normal 5-1  
starting up the unit 5-1

## P

parts  
replacements 7-3  
PCB  
battery replacement 7-3  
communications interface 2-5, 8-13  
control electronics 2-4  
controller 8-13  
DC distribution 8-5  
status LEDs 8-13  
physical specifications 9-1  
port  
address 6-3  
communications interface PCB 6-8  
ID 6-6  
power supply  
optional 4-28  
optional 24 V 4-29  
preventative maintenance  
checklist 7-2  
product  
compliance 1-4  
labels 1-3  
protection system  
detection controls 2-4  
PV array  
input 3-4

## R

register  
Modbus mapping assignment 6-19  
registering  
inverter 6-4  
remote disable  
communications interface PCB 4-25  
making the connection 4-26

protecting other power sources 4-26  
user interface PCB 5-10

## S

safety  
directives and standards 1-5  
electrical 1-5  
equipment requirements 1-3  
fire prevention 1-8  
first aid 1-3  
guidelines 1-2  
unit lockout and tagout 1-8  
zone 1-3  
seismic  
requirements 3-1  
shutdown  
procedure 5-8  
specifications  
cooling 9-4  
efficiency 9-4  
electrical 9-1  
environmental 9-5  
physical 9-1  
standards 1-5  
start the unit 5-1  
status lights  
on communications interface PCB 6-4  
storage  
of inverter 3-2  
string calculator  
input voltage calculation 3-4  
sub panel  
AC 2-8  
DC 2-7  
subcombiner  
connections 4-15  
monitoring 3-7  
options 3-7  
wire sizing 4-15  
support information 8-18  
symbols  
in user manual 1-1  
on unit 1-3  
system  
diagram 10-1

## T

technical support 8-18  
terminal blocks  
options 4-18, 4-21  
torque requirements 4-18, 4-21

terms frequently used 1-9

transformer

    housekeeping 2-9

    isolation 2-9

troubleshooting

    connectivity 8-1, 8-13

    faults 8-4, 8-5

    inspection 8-2

    inverter 8-2

    warnings 8-3

turn on the unit 5-1

## **U**

unit

    icons and symbols used 1-3

    lockout and tagout requirements 1-8

    startup 5-1

    turning on 5-1

user interface PCB

    remote disable 5-10

    switch settings 6-10, 6-11

    switches 6-11

user manual

    alert boxes in 1-1

symbols and icons used 1-1

utility

    requirements 3-6

## **V**

voltage

    calculating DC input 3-7

    output 3-6

## **W**

warning in user manual 1-1

website 2-2

    for monitoring 2-2

weight

    of inverter 3-1

wire sizing

    for amperage 4-15

wiring

    requirements 1-6

    sizing 1-6

wye

    configuration 3-6

